GUIDELINES *for*

Developing Stand Density Management Regimes

Information Session

Facilitator's Guide

April 1999

BRITISH COLUMBIA
Ministry of Forests

106-0 5787 /

Acknowledgements

I would like to thank the Stand Density Management Working Group for their time and dedication to creating the guidelines this session was designed to communicate. Thanks also to TM Communications of Victoria for production of the materials for this session.

Bryce Bancroft
March, 1999

Information Session – Contents and Lesson Outline

This session is broken into seven sections, each of which contains a lesson plan, overheads and instructions.

Lesson 1: Introduction of the Topic and Format of the Session

- This lesson is designed to provide the format of the session (timeline), go over the information that will be covered, that is – Guidelines for Stand Density Management Regimes, the related chief forester policy and pertinent regulations and recommended expectations from the session.

Lesson 2: The Guidelines – An Introduction

- This session will provide an historical context of the issues.
- Go over the format and content of the guidelines.

Lesson 3: Biological Concepts of Timber Production – A Quick Review

- An overview of the biology of stand growth will be presented using the guidelines for examples and issues.
- How density management affects stand development, wood quality and forest health will be discussed and references provided.

Lesson 4: Economic Principles of Timber Production – An Overview

- This lesson will cover the material presented in the guidelines to allow questions and clarification of the information.

Lesson 5: Forest Planning Considerations – What is Out There?

- This lesson will discuss the importance using forest plans to guide treatments. The examples provided in the guidelines will be used and expanded on with provincial examples.

Lesson 6: Decision Process

- This lesson will go over a recommended decision process that incorporates management objectives with strategic practices and tactical prescriptions.

Lesson 7: Policy and Regulations

- This lesson will cover the chief forester's policy and the relevant regulations regarding density management decision making.

Adjourn

The information session is based largely on the new guidelines and is meant to provide a forum for clarification and questions regarding density management planning and implementation.

Lesson 1

Introduction of the Topic and Format of the Session

30 minutes

Lesson Objectives

- To provide the format of the session (timeline)
- To provide an outline of the information that will be covered – *Guidelines for Stand Density Management Regimes*, the related chief forester's policy and pertinent regulations
- To provide clear expectations for the participants of this session.

Method: Introduce Topic and Timetable – Lecturette

- Go over the session outline
- Describe the intent of the session
- Introduce the three components that will be covered – guidelines, policy, and regulations
- Go over the contents of their binder. It has been created as a place to store relevant information on density management.

Audio Visual Requirements

- Overhead projector

Handout

- Session workbook

Session Outline

8:30 – 9:00	Introduction of the topic and format of the session
9:00 – 9:30	The Guidelines – An introduction
9:30 – 11:00	Biological Concepts of Timber Production – A quick review
11:00 – 11:30	Economic Principles of Timber Production – An overview
11:30 – 12:00	Forest Planning Considerations – What is out there?
Lunch	
1:00 – 2:00	Decision Process
2:00 – 3:30	Policy and Regulations

Coffee will be provided at 9:30 a.m. and 2:30 p.m.

Session Outline

Facilitator to go over points as provided below.

Lesson 1: Introduction of the topic and format of the session

- ▲ This lesson is designed to provide the format of the session (timeline), go over the information that will be covered – *Guidelines for Stand Density Management Regimes*, the related chief forester policy and pertinent regulations and recommended expectations from the session.

Lesson 2: The Guidelines – An introduction

- ▲ This session will provide an historical context of the issues.
- ▲ Review the format and content of the guidelines

Lesson 3: Biological Concepts of Timber Production – A quick review

- ▲ An overview of the biology of stand growth will be presented using the guidelines for examples and issues.
- ▲ How density management affects stand development. Wood quality and forest health will be discussed and references provided.

Lesson 4: Economic Principles of Timber Production – An overview

- ▲ This lesson will cover the material presented in the guidelines to allow questions and clarification of the information.

Lesson 5: Forest Planning Considerations – What is out there?

- ▲ This lesson will discuss the importance using forest plans to guide treatments. The examples provided in the guidelines will be used and expanded on with provincial examples.

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Lesson 7: Policy and Regulations

- ▲ This lesson will cover the chief forester's policy and the relevant regulations regarding density management decision making.

The information session is based largely on the new guidelines and is meant to provide a forum for clarification and questions regarding density management planning and implementation.

Introduce the Participant's Workbook

Describe what materials are provided – Guidelines

1. Participant's Workbook – has copies of the overheads and relevant notes, many of which are from the guidelines.

Lesson 2

The Guidelines – An Introduction

30 minutes

Lesson Objectives

- To provide historical context of the issues
- To provide an overview of the contents of the guidelines
- To provide clear expectations for the participants of this session.

Method: Introduce the Guidelines – Lecturette

- Go over the chronology of events leading up to the guidelines
- Walk through the contents of the guidelines – suggest areas where we will go into more detail

Audio Visual Requirements

- Overhead projector

Handout

Background

1996

STAND DENSITY MANAGEMENT WORKING GROUP

TASK

Create a framework to address contentious issues surrounding density management.

RESULT

These guidelines and philosophical change.

5000

Background

Facilitator to go over points as provided below.

The chief forester formed a Stand Density Management Working Group (the Working Group) in February 1996. The mandate of the Working Group was to provide a decision framework to address some contentious issues surrounding the effects of stand density.

- ▲ The Working Group consisted of five members from industry (Coast Forest and Lumber Association[2], Northern Forest Products Association, Interior Lumber Manufacturers Association, Cariboo Lumber Manufacturers Association) and five from Ministry of Forests.

Working Group deliberations considered the full range of stand density management practices, from initial espacement, through pre-commercial thinning (juvenile spacing) to commercial thinning.

The main emphasis, however, was pre-commercial thinning practice.

- ▲ Conclusions and recommendations are based upon a primary consideration of timber production, its implications on economics and forest-level planning.

Additional background

Density management is about achieving desired future forest conditions.

1984 – spacing was requested to be part of basic silviculture funding.

1987 – Bill 70 introduced spacing of stands over a “maximum” density for Pli and drybelt fir.

Treasury board required legislation be designed so that some costs of producing desired future forest conditions are paid by those who harvest. This was in anticipation that government funds would not always be available (i.e., potential countervail issues, plethora of disjunct funding sources – 18 over the last 10 years).

1988–1990 – numbers by district and region varied by philosophy and survey methodology.

1990–1991 – Industry Ministry Committee try to determine an appropriate “maximum” density for Pli – no agreement – Research and Silv branches set the number at 5000 sph.

Feb 1994 – New SP Regulation with “maximum” density for all coniferous tree species.

March 1994 – chief forester directive that 5000 csph is the ‘maximum’ density for all even aged stands. Purpose of the CF was to: stabilize SP approval.

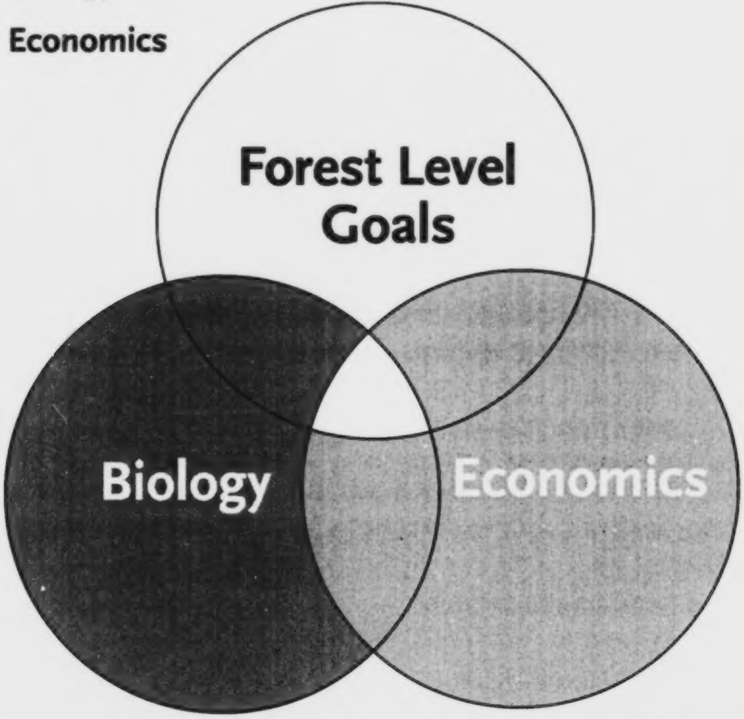
Management unit specific numbers were part of the directive but were not acted upon.

NOTE: “Maximum” density is no way related to height repression density!

Philosophical Shift

The three main components –
Density management from a simple number...
to a synthesis driven by...

- **Objectives, governed by**
- **Biology and**
- **Economics**



Forest Level Goals

Biology

Economics

Philosophical Shift – The three main components

Facilitator to go over points as provided below.

The Working Group advocates a philosophical change in the approach to stand-level decision-making. Selecting an option from a predetermined range of acceptable density regimes or treatments is not a responsible approach to making a management decision. Rather, technically sound, stand density management demands a structured process of thought and analysis which is based on knowledge from a number of disciplines.

The guidelines provide a decision framework which supports this new philosophy.

- It is designed to organize and guide the prescriptive thought process, rather than specify appropriate density regimes or default density standards.
- It also incorporates up-to-date stand density management concepts and information essential to the decision process.

Although not addressed in the guidelines, the process of forest-level goal setting is an important prerequisite to stand-level decision making. Given clearly stated, higher level direction, practitioners will find the information (knowledge) and framework (structure) elements of this guidebook helpful in developing and justifying stand-specific prescriptions.

The rest of the session will delve into the parts identified above, the recommended decision process and the policy and regulations that are in place to guide compliance.

Guidelines Structure

- Introduction background
- Biological concepts
- Economic principles
- Forest planning considerations
- A structured decision process
- Density management planning tools
- Glossary
- Predicting future timber values
- Tactical analysis and design

Guideline Structure

Facilitator to go over points as provided below.

The intent here is to show what information is found in the guidelines. We will briefly go over the chapter headings to provide a clear picture of what is provided in the guidelines.

***Note:** While this may appear tedious and, to some, 'a waste of time' as they too can read, reinforce that this is an open session where points not clear to the reader/participant can be addressed. We will also use examples outside of the guidelines to highlight key points.*

Introduction and background

Biological concepts of timber production

We will go into more detail on important biological concepts as they relate to density management. The key is that if it doesn't make sense biologically – don't do it!

Economic principles of timber production

We will discuss key elements of economic evaluations and stress the linkage to forest-level planning as well as stand-level analysis.

Forest planning considerations

The importance of forest-level objectives will be stressed.

Examples from current work in BC will be used to highlight opportunities.

A structured decision process

The decision framework will be presented along with a real world example.

Glossary

We will go over all glossary entries looking for the most arcane. Just kidding – but useful as it has biological, economic and planning definitions that may not be familiar to all. (We will just mention its presence).

Appendix 1 – Predicting future timber values

This appendix will help with the economic analysis we will use points drawn from it when we discuss the economic principles.

Appendix 2 – Tactical analysis and design

We will go over the examples highlighting the assumptions and the conclusions. The role of forest-level planning will again be re-emphasized.

Lesson 3

Biological Concepts of Timber Production

1.5 hours

Lesson Objectives

- To promote a common understanding of biological principles that underlie the effects of density management
- To provide an overview of wood quality and forest health as they relate to density management.

Method: Introduce the Guidelines – Q&A, Lecturette, Video

- Introduce biology section
- Show biological concepts video
- Go over points to emphasize concepts
- Present recent information on wood quality as it relates to density
- Review the main points of Pacific Forestry Centre Technology Transfer Note No. 12, November 1998 regarding forest health and density management.

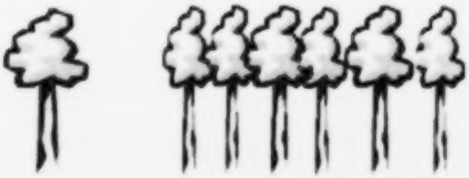
Audio Visual Requirements

- Overhead projector

Handout

- Technology Transfer Note No. 12, November 1998

Why Do Density Management?



Benefits of Density Management

- Turn to your neighbour exercise – 5 minutes for contemplation, 10 minutes to summarize as a group.

What possible management objectives do you believe density management (particularly pct [pre-commercial thinning]) will achieve?

- Alleviate timber supply gaps
- Improve habitat or riparian function
- Set up stands for future entries
- Reduce risk of blowdown or snow damage

Any others?

- Employ forest workers

Mention only:

Pruning

- Provides clear wood

Fertilization

- Additional volume if all things go well (i.e., appropriate site, species and treatment).

We will concentrate on density manangement.

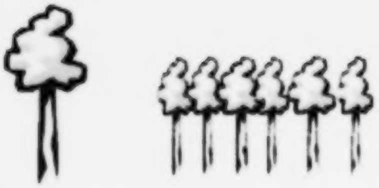
We now want to translate the objectives from above to identify structural attributes that are behind the assumptions.

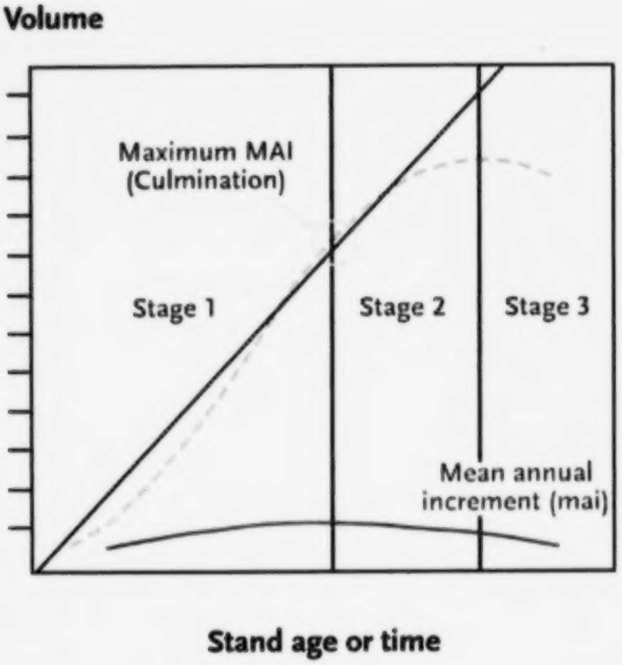
How does density affect individual tree growth and volume production? (from the executive summary)

- Stands regenerated or spaced (pct) to relatively high densities (e.g., 1500–10 000 trees/ha) have small differences in volume and diameter at harvest.
- Stands regenerated or spaced (pct) to relatively low densities (e.g., 250–1000 trees/ha) have larger piece sizes at harvest because more growing space is available to each tree, lower volumes per hectare because of slow site occupancy following treatment, and longer biological rotations.
- That is, there is a trade-off between tree diameter and stand volume which is most clearly reflected in stand and stock tables as opposed to volume per hectare and average diameter. The diameter benefits of spacing diminish the longer treatment is delayed beyond crown closure

We will look more closely at the key factors that influence the magnitude of the generalized statements provided.

Volume Over Time – The Basics





Growth and Yield – Measures Over Time

Volume over age – how the various measures of growth interact

The lines on the graph:

– – – – – This line depicts the total volume (over some determined minimum diameter) over time. Note it goes through three stages on the graph.

Stage 1 – This early period is where the stand grows rapidly and puts on the most volume over the shortest period of time.

———— Mean annual increment – the total increment to a given age in years divided by that age.

Stage 2 – Begins where MAI culminates. This occurs at the inflection point on the volume over age curve). This point is called culmination of mean annual increment, as MAI slows after this point. As can be seen the total volume is still increasing but at a lower rate than in stage 1.

Stage 3 – Is the stage where volume growth declines – larger and larger trees die, with the loss of each it affects the total volume on site. Height growth continues to slow in this phase resulting in less volume growth.

This stage often has reduced stocking due to insect and disease and other age-related mortality factors.

Volume Over Time – The Basics

Site productivity is relatively

FIXED

Climate and site dictate productivity.

Site Productivity is Relatively Fixed

The production potential of a particular population of trees growing on a given site is a function of site and tree resources.

The productivity of the site resource, for example, is determined by the inherent characteristics of the soil and climate.

These characteristics are essentially fixed, although the effects of external factors (e.g., poor soil management, adverse climatic change, industrial pollutants) may temporarily or permanently impair site productivity.

Intensive forestry practices such as cultivation, irrigation, drainage, and fertilization may also effect temporary or permanent increases in production potential. Large productivity gains are rarely practical, however, because production-limiting factors are costly to manipulate.

The productive capacity of a particular species or species mixture is governed by its ability to utilize the site resource. This is a function of the physiological and functional characteristics of the species, and is largely fixed. There are, however, notable exceptions:

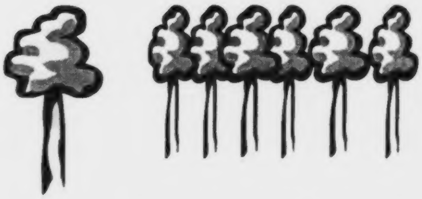
Go over these exceptions.

1. Silvicultural selection for tree vigour can either increase or decrease the efficiency of production because of the wide variation in the productive potential of individual trees.
2. Inadvertent use of unsuitable provenances can lower species productivity.
3. Selection and use of improved growing stock in future managed stands may increase natural productivity through genetic gain.
4. Repression, a biological phenomenon that is particularly important in lodgepole pine, can substantially reduce the height growth and productivity of all trees in stands established at high densities, particularly on sites of average or low productivity.

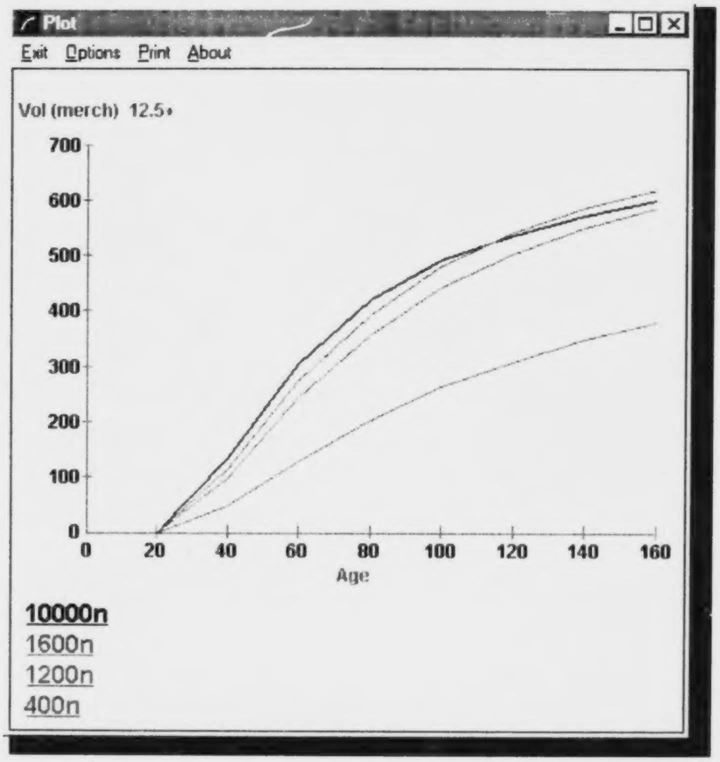
Apart from these site and species exceptions, it is reasonable to assume that stand productivity potential is fixed.

We will now look at what spacing does to the volume over age curve using TIPSY output.

Volume Over Time – TIPSY Runs



Using TIPSY to see how density affects volume

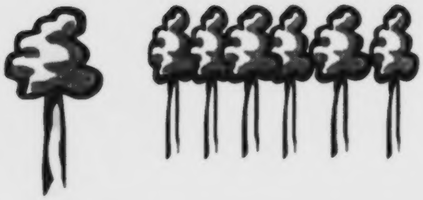


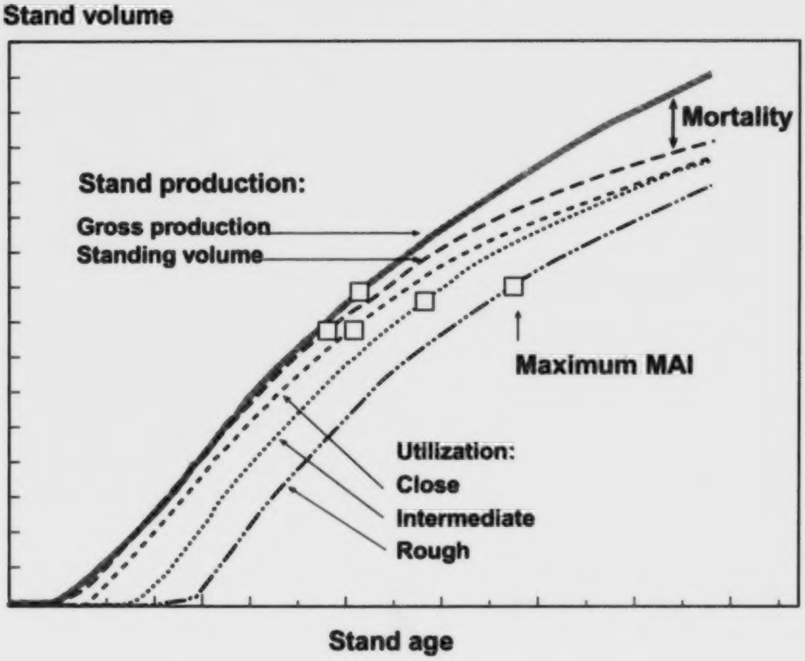
TIPSY Output

TIPSY is the acronym for Table Interpolation Program for Stand Yields – from a database generated by the growth model TASS. TIPSY was originally created in May 1991. TASS is an abbreviation for Tree and Stand Simulator. It is a biologically oriented model. It grows stands tree by tree in a three dimensional space in a computer and simulates silvicultural treatments.

This diagram shows TIPSY over age runs of Pl SI 20 with no OAF adjustments for starting densities of 10 000 sph, 1600 sph, 1200 sph and 400 sph (all natural regeneration).

Stand Production





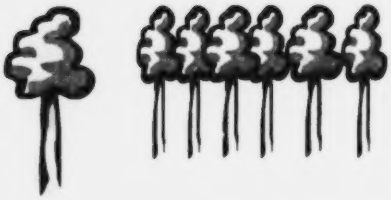
Stand production

Theoretically, near-maximum production in monocultures is realized when a stand fully occupies the site quickly, and performs to its potential throughout the rotation. Actual stand production is lower if crown closure and site occupancy are delayed by low establishment density. Similar yield reductions occur if portions of the site remain unoccupied because of factors such as inadequate stocking, brush competition and pests.

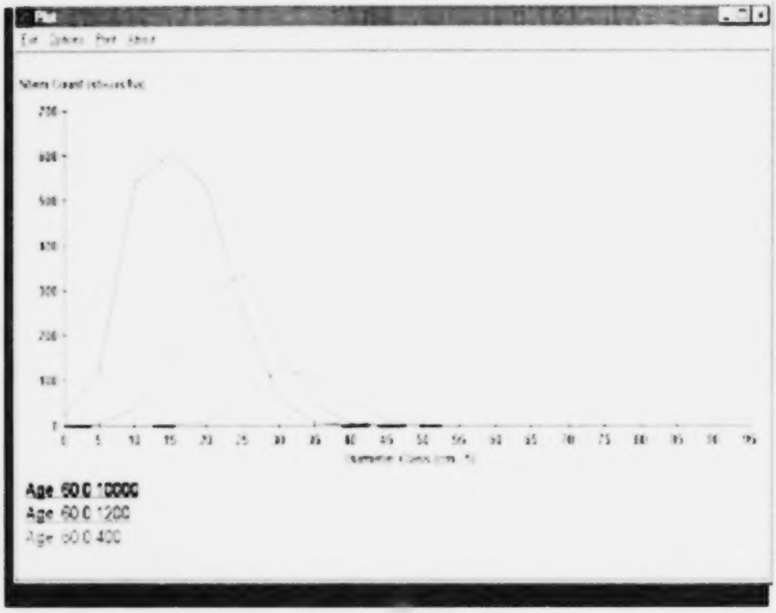
Full utilization of stem wood is achieved if all mortality is harvested as is illustrated by the gross production curve in Figure 2 from the guidelines. The difference between gross production and standing volume represents the volume lost to mortality.

Maximum theoretical stand production must be tempered by consideration of economic merchantability. Merchantability standards, such as top diameter, stump height and minimum diameter at breast height (DBH) are economic constraints that reduce the yield of the stand, particularly when the trees are small. The difference between the curves for standing volume and close utilization shows that tops, stumps and trees less than 12.5 cm reduce the volume by a fairly constant amount throughout the rotation.

TIPSY Runs



TIPSY derived diameter distribution from different densities


Plot
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Age 60.0 10000
Age 60.0 1200
Age 60.0 400

TIPSY Output

One of the main objectives of pre-commercial thinning (pct) is growing larger stems faster. The following TIPSY graph shows how TIPSY derived stems are distributed at year 60 for the same Pl SI 20 stand.

The tree lines are for 10 000 naturals/ha, 10 000 naturals pre-commercially thinned to 1200 sph, 10 000 naturals pre-commercially thinned to 400 sph.

- You will note that all have bell shaped distributions.
- There are significantly fewer stems in the thinned stands and in general, the stems are larger.
- The smallest stems were removed from the thinned stands.

What this means is we will have fewer logs to handle, a more uniform piece size, with a limited number of larger stems overall. We will still have a range of diameters including some smaller stems. For the most part we will not have an assemblage of only large trees.

Let us now look at an example showing this response with real data. In BC we do not have many long term spacing trails. We do have the Schenstrom plots at Cowichan Lake (multiple thinnings) established in 1929, but due to the multiple entries looking at results is complex. Instead we will look at a simple spacing trial for Hw established in the Pacific Northwest in the 1960s.

Spacing Trial Results

Target average spacing after thinning (m)	Actual post-thin density (stems/ha)	Actual post-thin average spacing (m)	Standing vol. at last common ht. (26.8 m)	Cum. yield vol. at last common height (26.8 m)	Cum. prod. vol. at last common ht. (26.8 m)	Est. thinning vol. (12.5+)	Cum. mort. (12.5+)
Control	8000	1.12	574.5	574.5	582.5	0.0	8.0
1.83	1975	2.25	601.7	604.6	621.3	2.9	16.7
2.44	1544	2.54	619.4	619.7	638.5	0.3	18.8
3.05	963	3.22	534.6	538.0	538.0	3.4	0.0
3.66	803	3.53	606.7	610.2	610.7	3.4	0.5
4.27	519	4.39	439.4	442.3	458.6	2.8	16.3

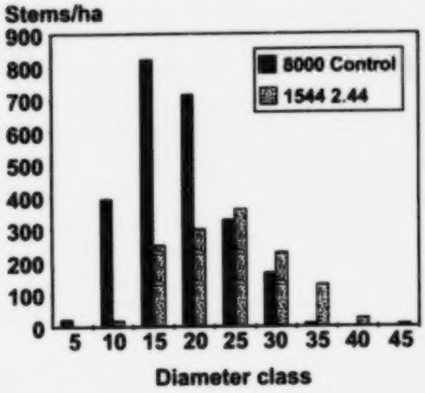
Stock table – Volume per ha (m^3/ha)

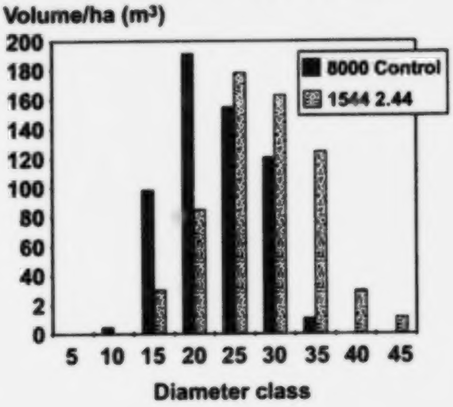
Diameter class (cm)	8000 Control	1975 1.83	1544 2.44	963 3.05	803 3.66	519 4.27	sph spacing
<2.5							
5							
10	4.3	1.6					
15	98.2	39.3	29.8	11.3	1.5		
20	191.0	112.8	84.7	22.1	18.2	4.5	
25	154.8	151.9	178.2	116.8	82.3	12.6	
30	120.3	176.4	162.6	184.1	117.2	34.5	
35	10.2	47.0	124.1	175.5	227.8	95.2	
40		35.1	29.1	24.8	139.0	80.8	
45		39.2	11.0		20.8	111.9	
50						100.0	
55							
Total	579	603	620	535	607	439	

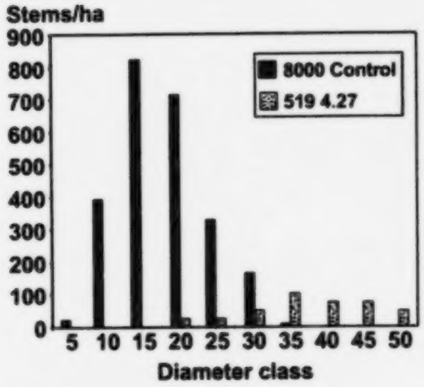
Data from a Coastal Experiment

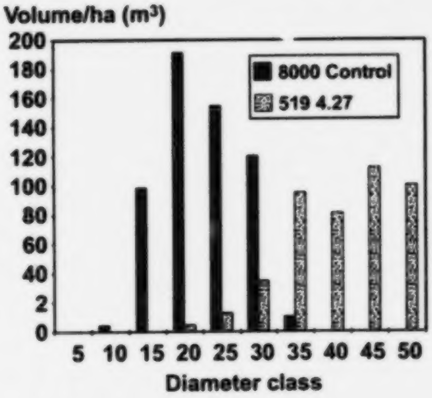
This is data from a Hw pre-commercial thinning trial conducted on the Olympic Peninsula (established in the 1960s). The following table provides a summary of treatments and volume at the last common measurement height (28.6 m). The site was monitored from age 13 to 38, the site index is 36 m SI_{50}.

Coastal Experiment


Stand Table at 26.8 m
Control vs 1544 sph pct spacing


Stock Table at 26.8 m
Control vs 1544 sph pct spacing

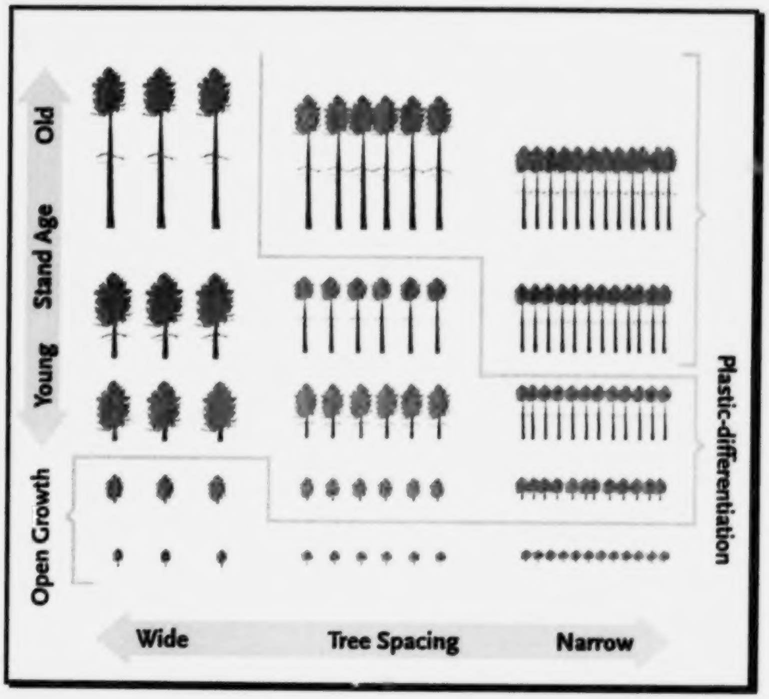

Stand table at 26.8 m
Control vs 519 sph pct spacing


Stock Table at 26.8m
Control vs 519 sph pct spacing

Data from a Coastal Experiment

Variation in Growth – Espacement

How Trees Grow in the Forest


Old
Stand Age
Young
Open Growth
Plastic-differentiation
Wide
Tree Spacing
Narrow

How Forests Grow

The next series of overheads are adaptations of the stand structural stages as described in Oliver and Larson, 1996. They show how stands grow and what various factors will influence growth and hence data collection and treatment decisions.

- What constitutes wide versus narrow. Wide spacing is likely near minimum stocking values (700 sph is 4.06 m intertree distance using triangular spacing, 400 sph is 5.37 m.) Dense spacing likely means 10 000 sph plus.
- The left axis shows young open grown at the bottom and old above.

What is being influenced by tree spacing?

- Tree height – the most dense stand is the shortest and has the least live crown.

Is this conventional wisdom? Is this how it works in the real world?

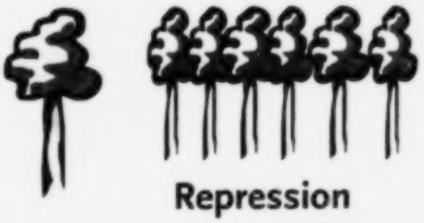
- For Pl above a certain density it does (from 10 000 to 30 000 total stems per ha are densities where height repression can begin for Pl). This phenomenon is called height repression and will be discussed later.

What is it about this stand structure that seems somewhat peculiar?

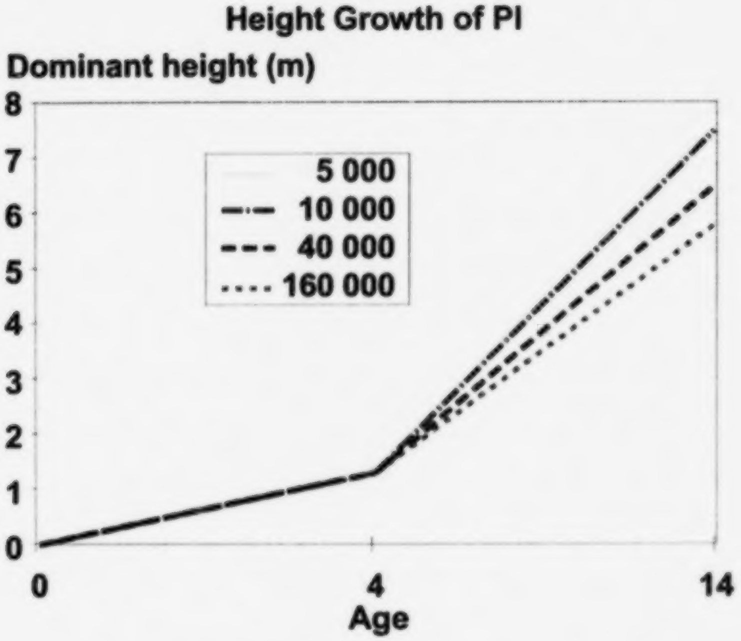
- No differentiation – all trees are the same size. Normally there will be some form of differentiation, unless there is no genetic or microsite variation (e.g., cones in a farm field).

KEY – in BC repression has been found in Pl. To avoid reduced heights and volumes, treatment is required to reduce density .

Stand Differentiation



How Trees Grow in the Forest



Adapted from the guidelines (page 7).

Repression

Repression is a biological phenomenon whereby tree growth and stand development fail to exploit the potential productivity of the site. The impact is widespread (Goudie 1996) in stands of lodgepole pine but not in other species.

Biology

Repression curtails height and volume increment of lodgepole pine shortly after the growing space is fully utilized in stands established at extreme densities. The process usually begins before trees reach a height of 2.0 metres, although stands with 1 000 000 trees/ha may be affected when only 0.2 metres tall.

Espacement trials (Carlson and Johnstone 1983) show that the height growth of plantations with 13 500 or more planted trees are affected (Figure 1), and future measurements may indicate minor repression in stands planted with 10 000 trees. The pattern of growth and development of repressed stands resembles that of stands growing on sites of much lower productivity; consequently, merchantable yields will be achieved considerably later than had repression been avoided. Repression does not, however, cause stands to "stagnate" or cease development, as was once believed.

Impact – Mainly on fire origin stands

Growth losses are particularly dramatic in repressed fire-origin stands of lodgepole established with more than 50 000 trees per hectare (Mitchell and Goudie 1980), particularly on sites of relatively low productivity. At extreme densities (500 000 + trees/ha), stand production may be reduced by as much as 60 per cent.

Repression is not likely to be a serious problem in stands that regenerate after logging because establishment densities are much lower, trees seed-in over 5 to 10 years (instead of 2 to 3 years), and clumped (less uniform) tree distributions are more common. The lower densities and greater tree-size diversity of post-logging stands minimizes the risk of repression losses.

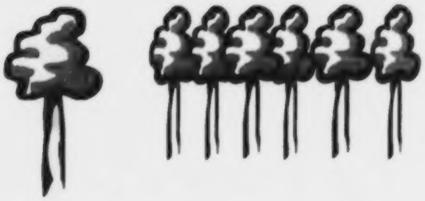
Repression is also unlikely in plantations, unless supplemented by concurrent, natural, in-fill regeneration. The impact of dense, but delayed, natural regeneration on planted lodgepole pine stands is not presently known.

Response to Treatment

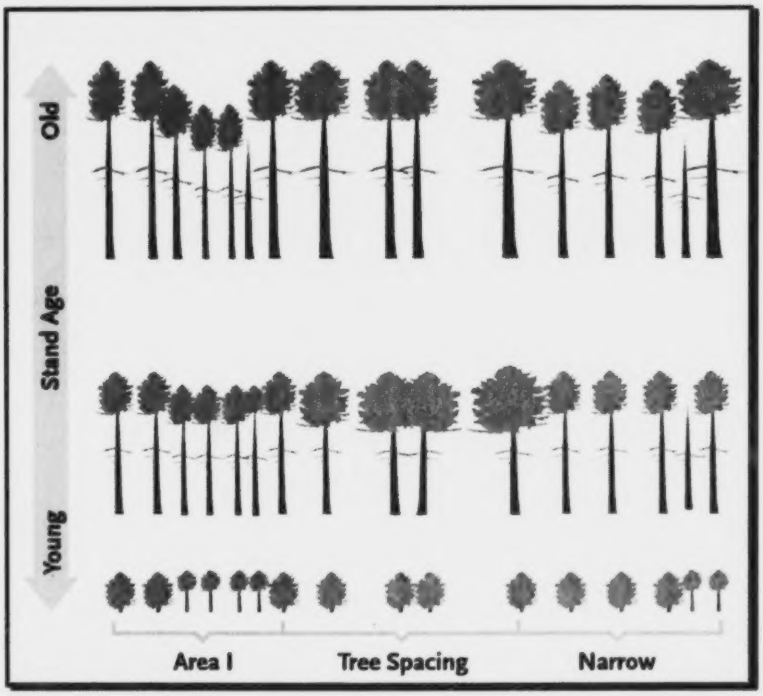
Stand density interventions are an effective means of preventing repression in lodgepole pine if treatment occurs before the onset of repression. Stands which are thinned after the onset of repression do not show a consistent height growth response to treatment (J.S. Thrower and Assoc. 1993). However, there is evidence of an independent response in diameter growth.

Until more is known about treatment response it is reasonable to assume that the early height growth of repressed stands is indicative of future productivity.

Growth Variation – Espacement



How Trees Grow in the Forest


Old
Stand Age
Young
Area I
Tree Spacing
Narrow

How Stands Grow – The Effect of Espacement

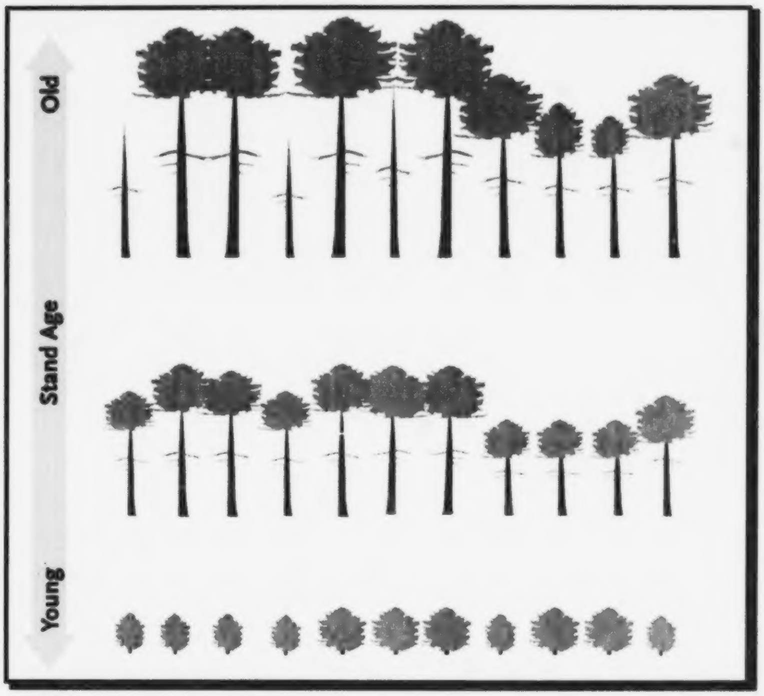
Note this is not the total story.

This overhead depicts the variation in growth due to original spacing. What does the diagram show us?

- What the spacing trials show is that trees with more room to grow will have larger crowns and larger diameter growth potential. Dense stands will have some stems in understorey positions that will be suppressed by their neighbours.
- Area 1 is relatively dense from the start. Crowns lift early resulting in thin stems with reduced growth potential – the clumps found in this stand show better growth on the edges. Therefore, any treatment response needs to take into account the size of the clumps, the density in the centre and whether the vigour of the trees is sufficient for response if density is reduced. If we wait too long (crowns are now small) diameter increases will be slowed, reducing its effect.
- Note (rule of thumb – from OSU Extension Services, 1997, EC 1189) – If the clump is over three crown widths wide, the clump should be managed the same as the rest of the stand. If not, leave along the edges slightly closer than the prescribed spacing (they are already somewhat open due to their position on the edge of clump). **Don't leave overdense areas to compensate for holes in the stand.**
- The key element of this diagram is that crowns respond differently depending upon density. Thus, removing trees from the middle of clumps and leaving the edges intact will provide more trees access to more light. This will result in larger crowns, allowing the trees to grow larger.

Growth Variation – By Genes and Microsite Variation

How Trees Grow in the Forest


Old
Stand Age
Young

How Stands Grow – Due to Genetic Makeup and Microsite Variation

Remember: This too is not the total story – what is left? (Differential establishment times, different species in the mix.)

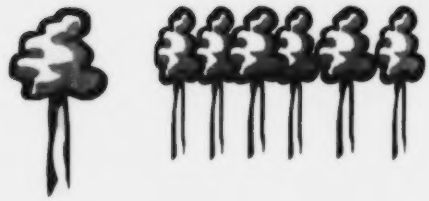
This overhead depicts the variation in growth due to microsite and genetic variation. What does the diagram show us?

- Sometimes even where trees are well spaced they will not achieve the size of others due to genetics and microsite differences.
- It is likely good to think in terms of the tree living within a probability matrix. As the Duke brothers found out in *Trading Places* neither nurture nor nature acts alone.
- The simplified matrix looks something like this.

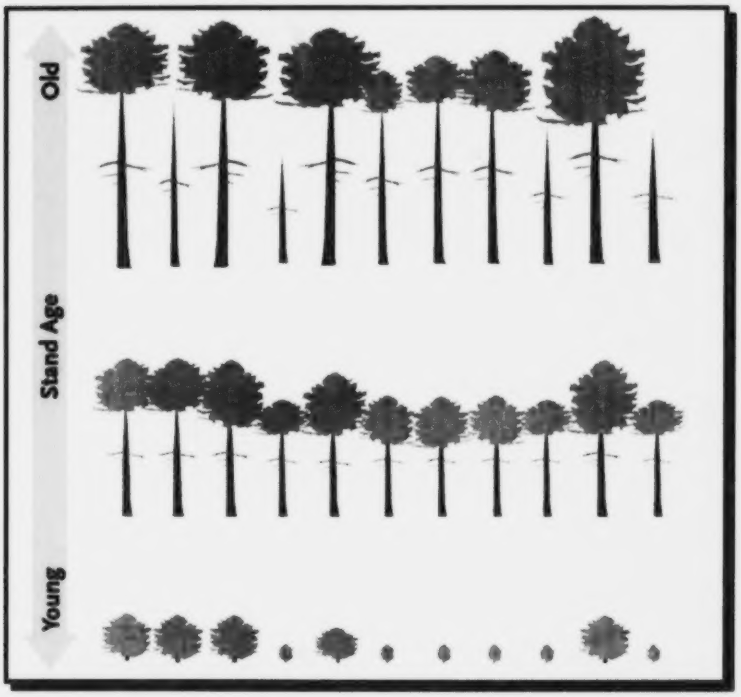
Good Microsite Good Genes *Big Trees*	Good Microsite Lousy Genes *Medium Trees*
Poor Microsite Good Genes *Medium Trees*	Poor Microsite Lousy Genes *Small Trees*

Because of this we are likely to get a range of sizes on each site. However as the bottom boxes attest the best we will be able to get on poor sites are smaller trees within the same time frame as on better sites.

Timing of Establishment
Stand Differentiation



How Trees Grow in the Forest


Old
Stand Age
Young

How Stands Grow – Timing of Establishment

This too is not the total story – what is left? (Different species in the mix.)

This overhead depicts the variation in growth due to differences in the time of establishment. What does the diagram show us?

▲ Depending upon stand density and aspect, the late starters will likely never be in the top portion of the crown (unless they are climax species and outlive the early successional overstorey). Late starters can be on good sites and have good genes but, if they are slow to grow in the early years, they will not have access to the sun that their neighbours do, resulting in smaller crowns and less growth.

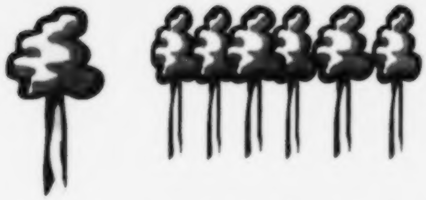
Stand differentiation

Mortality in stands is natural and will happen with time. One of the objectives of incremental silvicultural activities is to capture some of the growing space that would have gone to mortality and channel it onto a potential crop tree.

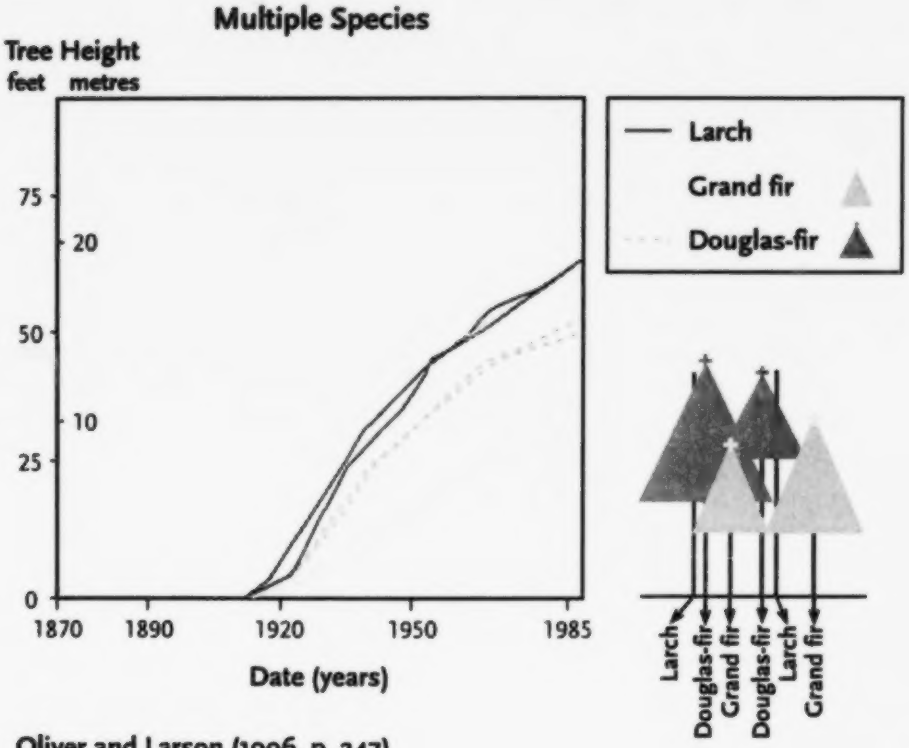
Stand differentiation is the result of stand density, genetics, growing environment, and time of establishment and is further tangled by multiple species. The resultant stand will likely have some dominant trees, mostly codominants and some intermediate and suppressed trees. The intent of most juvenile spacing treatments is to maintain or enhance the diameter growth of the trees left on site.

We will look now at the role of species in stand differentiation.

Stand Differentiation – Multiple Species



How Trees Grow in the Forest



Oliver and Larson (1996, p. 247)

How Stands Grow – Multiple Species

This overhead depicts the variation in growth due to **species differences.** In some cases species are adapted to grow in an understorey position (e.g., grand fir), or grow with other species (e.g., Fdi and Larch). In other cases, if one species gets a head start on the other species they will likely succumb to mortality first resulting in lower numbers of the slower growing species after crown closure. In other cases, the initial stratification may change over time if the component species have different patterns of height-growth. For example, the height growth of paper birch slows dramatically after about age 40. Other species in the stand may subsequently overtake and surpass the birch in height. The stratification can also be altered by insects and diseases that preferentially damage and weaken one species or stratum in the mixture.

In stands of mixed species, the variation in tree size is even more pronounced because of the wider range of inherent rates of juvenile height growth. Stand mixtures of species tend to differentiate into distinct layers or strata when differences in height growth are large. This initial stratification can persist if the slower-growing species are shade tolerant, or if sufficient sunlight can pass through the foliage of trees in the upper stratum.

Diameter distributions in mixed-species stands generally reflect the height stratification. The species in the upper and lower canopy occupy the larger and smaller diameter classes, respectively. If the slower-growing species are shade tolerant, diameter distributions are often skewed toward smaller sizes. Broadleaf species sometimes exhibit a different height-diameter ratio than conifers and consequently appear lower down in the diameter distribution than they are in the height distribution.

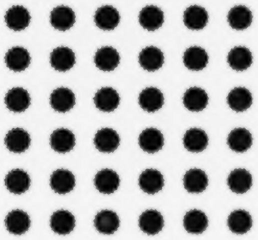
Canopy stratification patterns can be altered if the species with slower juvenile height growth have an advantage in early stand development. They may regenerate in advance of the faster-growing species, or density control measures may free them from competition during the juvenile phase of slow growth, thereby ensuring they do not lag far behind the faster-growing species at the time of stand canopy closure. Silvicultural treatments undertaken at or shortly after establishment can create single-layered stands of species that would otherwise naturally form stratified canopies.

Stand Differentiation – Multiple Species

How Trees Grow in the Forest

Multiple Species

1. Species monoculture

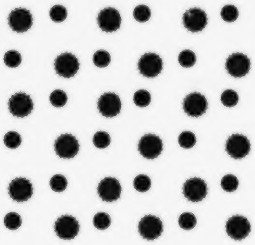


Legend

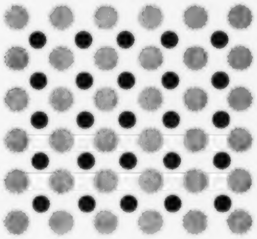
Species A ●

Species B •

2. Species mixture – substitution



3. Species mixture – addition



How Stands Grow – Substitution and Addition

Relative to monocultures, the yield relationships of **stand mixtures** are less well defined because of the numerous possible combinations of constituent species and their relative proportions.

- ▲ The yields from stand mixtures can be either greater than or less than the yield from corresponding single species stands depending on the component species, stand density, height stratification patterns and site quality.

In order to better understand the complexity of mixtures and how they relate to monocultures, it is helpful to visualize mixed species stands from the perspectives of substitution and addition.

Substitution

In the **substitution** perspective, a mixture is derived from a monoculture by substituting trees in the monoculture with trees of another species, keeping the total stand density constant.

In this overhead, for example (Figure 3 from the guidelines) the monoculture of species ***A*** (larger stars) at 600 per ha can be transformed into a mixture by substituting 300 trees of species ***B*** (smaller stars). The yield of mixtures created by substitution are almost always intermediate between the yields of the two species in separate monocultures. Notable exceptions are combinations in which one species enhances the growth of another, such as some mixtures of Douglas-fir and red alder. Otherwise, the stand yield of the mixture is usually close to the average production of the component monocultures when weighted by the species proportions in the mixture.

Addition

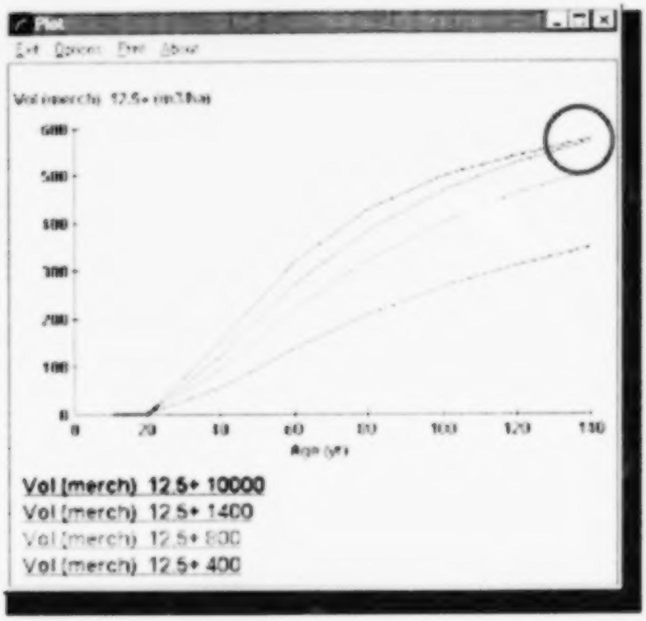
In the **addition** perspective, a mixture is derived by adding to a monoculture some trees of a different species.

From the monoculture of species ***A*** at 600 per ha, we can create a mixture by adding another 600 per ha of species ***B*** (3), bringing total stand density to 1200 per ha. Yields of mixtures created by addition can be greater than yields of monoculture simply because there are more trees.

Density Management Practices

Espacement

Holes reduce growth potential


Plot
Exit Options Print About
Vol (merch) 12.5+ (m3/ha)
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
Age (yr)

Vol (merch) 12.5+ 10000
Vol (merch) 12.5+ 1400
Vol (merch) 12.5+ 800
Vol (merch) 12.5+ 400

Lodgepole pine SI 20
What is crossover? Does it occur?

Espacement

Plantation espacement in B.C. since 1940 ranged from:

- about 2 metres (2500 trees/ha) to 4 metres (625/ha).
- Espacement in natural stands covers a much wider range, for example 1–1 000 000 trees/ha., and is much less regular.
- Full site occupancy is achieved quickly if the establishment density is moderately high and the spatial distribution of trees is uniform. **Uniformity increases in importance as establishment density decreases as more holes will be created.**

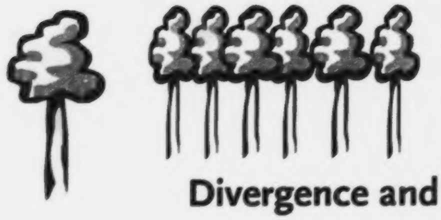
Volume production in the overhead **indicates less volume with decreasing establishment density.** Any clumping of the same number of stems will reduce the stand yield even further.

It should be noted that it is the unoccupied growing space or **"holes" in the stand canopy that reduce timber yield – not the clumpiness itself.** Low density stands produce less volume initially because there are too few trees to exploit the available growing space. The rate of stand growth improves after crown closure.

Cross-over

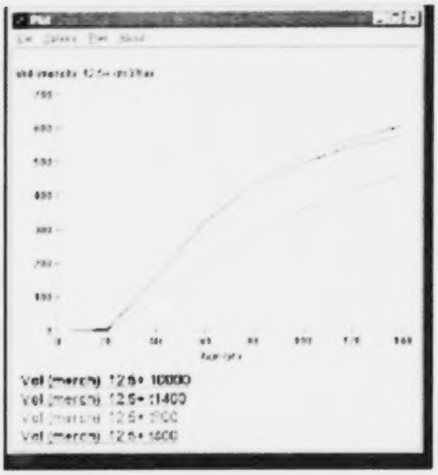
Theoretically, the growth rate of a low density stand could eventually surpass that of a dense stand, as predicted by yield projection models. This phenomenon, called *cross-over*, has not been observed in research plots in British Columbia, which are still too young to confirm or reject the theory. **Ministry data and models predict that cross-over is not likely to occur until well beyond acceptable rotation ages based on the culmination of mean annual increment.**

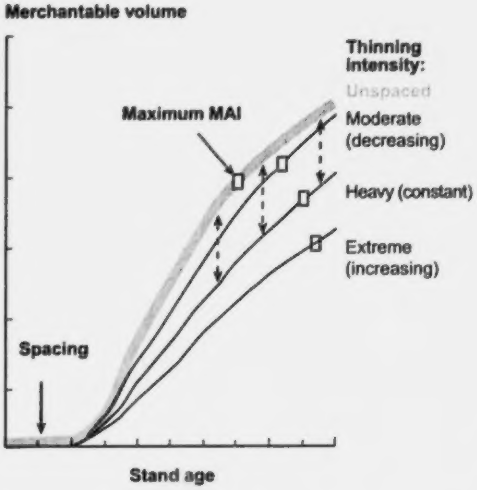
Density Management Practices



Volume Over Time in Spaced Stands

Divergence and Convergence





Lodgepole pine SI 20 and Figure 5 (guidelines)

Things to promote:

1. Leave crop trees of high vigour
2. PCT when height growth is expressed
3. PCT extremely dense Pl stands early
4. Maintaining potential "additive" trees

Volume Over Time – What Happens to Pre-commercially Thinned Stands

Pre-commercial thinning immediately reduces the number of trees, the occupancy of growing space and the standing volume per hectare.

- ▲ The magnitude of the reduction is related to the intensity of treatment.
- ▲ The subsequent development of the stand is more complex.

Crown cover normally increases at a diminishing rate until complete canopy closure occurs, and then levels off.

- ▲ The number of trees in the spaced stand remains fairly constant until the onset of crown closure, competition and mortality.
- ▲ Volume increment is reduced until the vacant growing space created by pct is fully utilized by the residual stand.
- ▲ The corresponding volume curves of the spaced and untreated stands will initially diverge and later parallel one another.
- ▲ Convergence of the curves usually starts shortly after mortality begins in the pct stand. The duration of each phase depends on the intensity of pre-commercial thinning and the level of utilization.

If only overtopped trees are removed and 100% crown cover is maintained, convergence will begin immediately without any divergence. On the other hand, a very heavy spacing will initiate a lengthy phase of divergence that could extend until the stand is harvested. Since one phase tends to dominate, volume curves can be described in terms of *decreasing, constant* or *increasing* departure as illustrated in the graph on the right.

The graph on the right (Figure 5 from the guidelines) shows a generalized situation. The degree of divergence or convergence will depend upon the situation. The TIPSY example shows extreme spacing (to 400 sph) results in increasing departure (divergence), while pct from 10 000 to 1400 actually results in greater volume production than the unspaced stand at 10 000 sph.

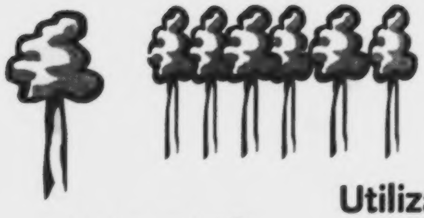
Key – at low densities you will lose volume, but not necessarily if you choose the residual density with this in mind.

Things to avoid

If you are trying to maintain stand volume at the same time as increasing individual tree diameter, avoid:

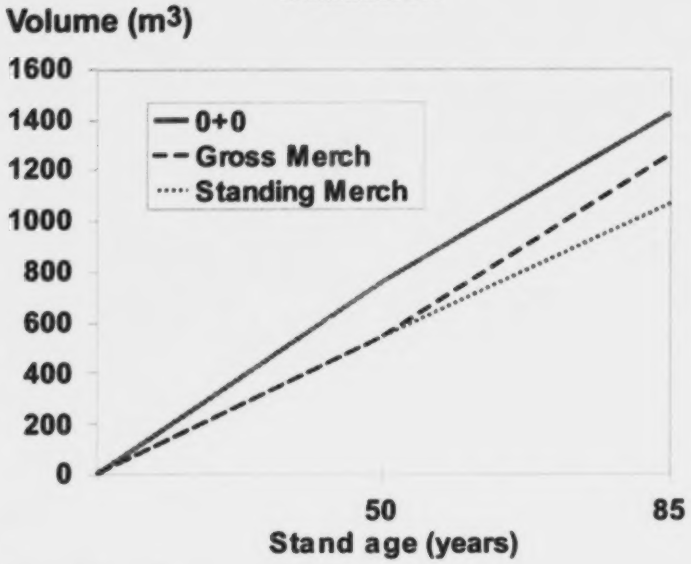
1. choosing crop trees of low vigour due to uniformity of spacing taking precedence
2. height growth potential is not obvious
3. pre-commercial thinning of extremely dense Pl stands is delayed past the onset of height repression
4. thinning out shade tolerant species that could add volume by growing in the understorey.

Commercial Thinning



How much volume is available from mortality?

Utilization



Potential volume gains

- 12.5 cm utilization – 160 m^3 (20%)
- If all mortality were captured – 350 m^3 (30%)

Is this reasonable/realistic?

Commercial Thinning

Commercial thinning occurs much later than pre-commercial thinning when the trees are larger. It creates relatively large holes in the stand canopy which are reoccupied slowly by the crowns of leave trees. The invading branches grow slowly because height growth is declining, as is the overall vigour of the stand.

When thinning commercially in British Columbia it is common to carry out a single entry not long before the final harvest.

- This entry would remove a wide range of tree sizes, with most coming from the lower diameter classes.
- In Europe, it is common practice to conduct a series of frequent, light, low thinnings intended to capture wood which would be lost to mortality if untreated.
- One typically compares the harvest volume of the untreated stand with the total volume (final harvest + all thinnings) taken from the treated stand.
- Lower utilization limits in Europe also increase the merchantable volume available from thinnings. A limit of 7 cm is common for both DBH and top diameter.

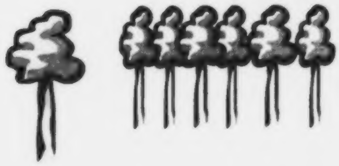
If we look at the mortality in an unthinned plot of Douglas fir from B.C. we can see how much volume is potentially available from a series of frequent, light, low thinning entries. That is, we will assume we are able to harvest and utilize each overtopped tree just before it dies.

- **In the graph, the uppermost "gross production" curve is what we get if all wood is salvaged by thinning without regard for merchantability limits.**
- **The middle "gross merchantable" curve shows what is left if tops (<10 cm), stumps (<30cm) and small trees (<12.5 cm) are not merchantable.**
- **The lowermost curve indicates the merchantable volume of standing trees if the stand was not thinned. The graph indicates that if all mortality in the stand is captured through repeated, light, low thinnings, it is possible to increase the harvest volume (12.5 cm+) by 20% at age 85 years. This increases to 30% with the harvest of all trees (0.0 cm+), tops and stumps.**

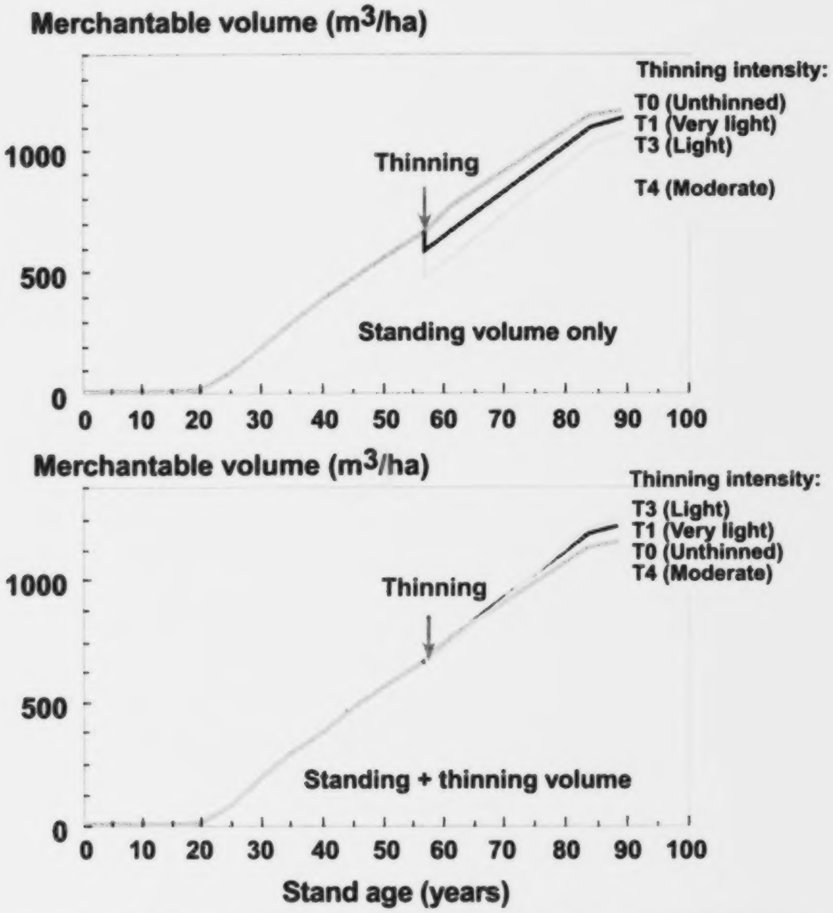
The lowermost curve in the graph displays the standing merchantable volume if the stand was not thinned (pages 16 and 17 in the guidelines).

- ▲ A series of light entries increases the total harvest because the space vacated by small-crowned trees is small, and frequent entries maximizes the opportunity to salvage trees before they die.
- ▲ A single heavy entry, timed well before the final harvest, will likely decrease the total yield because tree removals create large openings, resulting in less than full site occupancy by the residual stand. Furthermore, only one opportunity to harvest impending mortality will result in lost volume between thinning and final harvest.

Commerical Thinning



What does research tell us?



Commercial Thinning

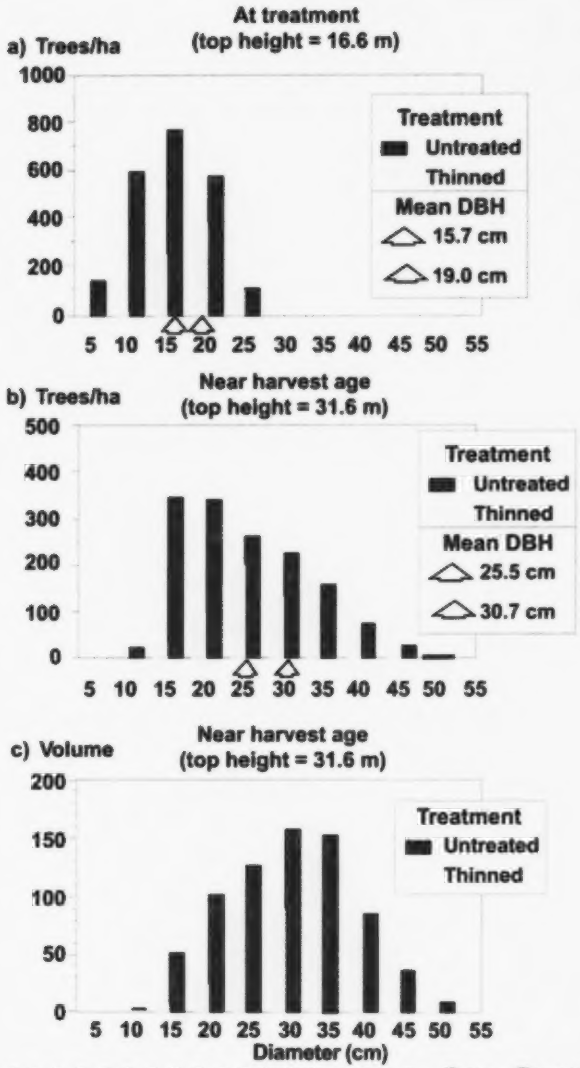
- The graph is from research on Coastal Douglas-fir (Omule 1988). Three levels of thinning intensity are shown along with the control.
- Volume removed – T1–14%, T3–29%, T4–41%.
- The top graph shows how the standing volume of the untreated and thinned plots developed over time. What this shows is the standing volume will go down with the commercial thinning entry. With the light thinning levels the volumes begin to converge and if very light will result in similar standing volume.
- Standing plus thinning volume result in slightly elevated amounts for T1 and T3, (5 and 7%) however they were not statistically significant.

Lower graph

- The point being made here is that CT may not effect final yields with light thinnings. With heavy thinnings the holes in the stand will result in volume reductions (T4–6%).

In the guidelines a hypothetical example is provided to emphasize how heavy thinnings will result in considerably less total volume.

Describing Density



Methods of describing density

- ▲ Stand tables
- ▲ Stock tables
- ▲ Stand or average DBH or volume
- ▲ Prime tree average DBH

Describing Density

Stand Tables

Stand tables indicate the number of trees, by diameter class, at a particular stage of stand development.

- Good for visualizing what the stand is made up of and where the majority of stems fit.

Stock Tables

A stock table displays volume, by diameter class, and enhances stand table data by identifying the diameters classes which contain the bulk of the volume. It is important to focus on the upper and middle diameter classes of each plot since they contain the trees of greatest volume.

- Good for visualizing where the bulk of the volume is concentrated
- Graph (c) illustrates a stock table comparison of the thinned and unthinned plots at 31.6 m of top height.
- Note that the "extra wood" in the unthinned stand is concentrated in the smallest diameter classes.

Stand Average DBH or Volume

The average diameter or volume of all trees in the stand provides a useful but narrow view of a stand, compared with a stand and stock table summary of stand structure.

- For example, in graph (a) thinning from below instantly raises the average diameter of the plot (15.7 to 19.0 cm) in what is known as the "chainsaw effect". This is caused by the removal of small trees during thinning, which inflates the arithmetic average diameter of the remaining trees.

Prime Tree Average DBH

If there is a wide range of establishment densities, it is useful to compare the development of prime trees (largest 250 trees/ha) because these trees will likely survive to harvest in all stands. Furthermore, prime trees are independent of the chainsaw effect in stands thinned from below. For example, the average diameter of the prime trees in the thinned and unthinned stands is 38.3 and 37.5 respectively.

▲ The prime trees in the thinned stand outgrew those in the unthinned stand, but the difference is small because prime trees do not suffer from the same intensity of competition as smaller trees in the stand. Prime tree diameter is largely insensitive to stand density, unless the inter-tree distance is quite large. For example, the stand depicted in the overhead was thinned late (16.6 m) to a residual density of 750 trees which will only stimulate the growth of prime trees for a short period.

In summary, while average diameter of prime trees and stand average diameter are informative statistics, they must be used cautiously when assessing stand response to density management. Both statistics have shortcomings in portraying stand structure, and neither should be used in isolation of other relevant information (e.g., the range of tree diameters or volumes, the average diameter of non-prime trees and stock and stand tables).

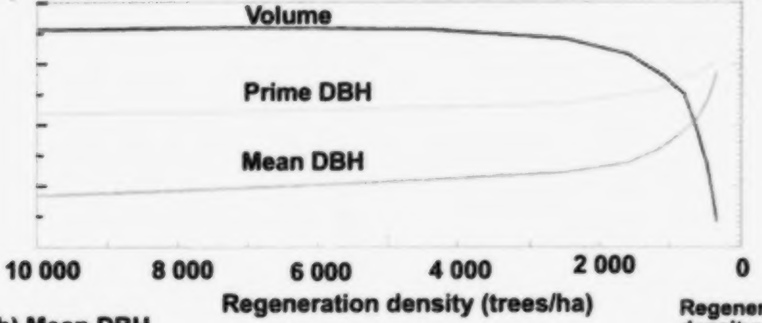
Note: ***The data shown in this example is from a stand spaced at top height 16.6 m. TIPSY spaces stands at 6 m on the coast and 4 m in the interior. Why?***

Example:
- ***near commercial size***
- ***crowns may (likely) have lifted, slowing reponse***

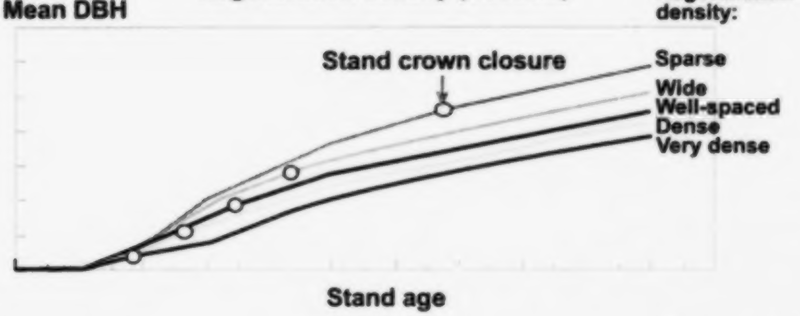
Volume Diameter Trade-off

What are these graphs telling us?

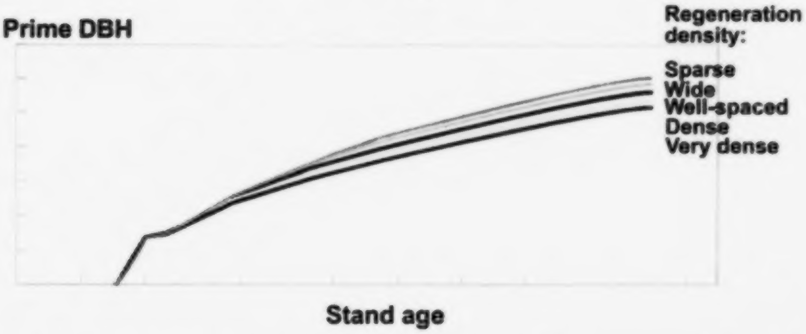
a) Volume



b) Mean DBH



c) Prime DBH



Volume Diameter Trade-off

The trade-off between stand volume and piece size achieved through espacement, pre-commercial thinning and commercial thinning should be evaluated using stand and stock tables.

- ▲ However, in the interest of brevity, volume per hectare and average diameter (all trees and prime trees) will be used in the following example.

The top graph – depicting hypothetical espacement densities shows volume remaining relatively constant over a range of regeneration densities from about 1500 to 10 000.

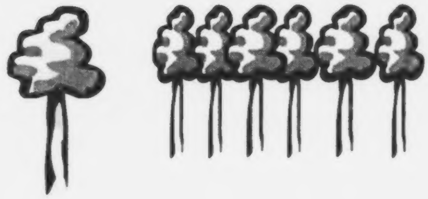
- ▲ Below 1500 stems per ha (at regeneration) volume production falls off. This is because it takes longer for fewer stems to reach crown closure, the empty space is not producing wood.
- ▲ Mean DBH shoots up below 1500 sph as trees utilize open space prior to crown closure. The prime DBH has a less dramatic effect.

Middle and lower graphs

- ▲ The increase in average diameter resulting from wide inter-tree spacing occurs prior to stand crown closure [graph (b)] with little or no increase thereafter attributable to establishment density. Since the graph in the overhead illustrates a stand espacement example, there is no artificial increase in diameter (i.e., chainsaw effect) immediately after treatment. The behavior of prime trees in graph (c) is similar, but much less dramatic.

Note: Rotation ages in graph (a) conform with the culmination of MAI. This ensures maximum sustained volume production. Planners may also use other criteria to determine the age of the final harvest. The attainment of a particular average diameter is a good example. However, they must be aware that technical rotations decrease the long-term stand volume production except in rare cases where the selected rotation age coincides with the culmination of MAI. At the forest level, planners have to consider trade-offs in terms of volume, diameter, rotation length and other relevant variables.

Wood Quality



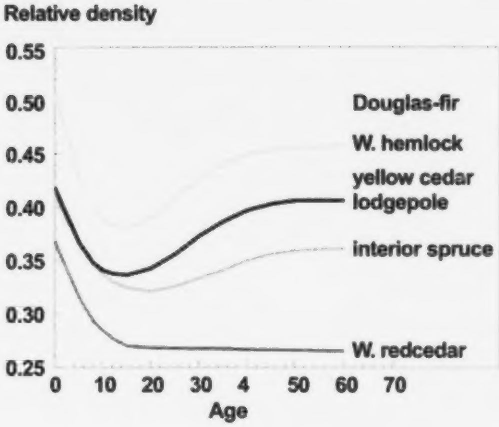
Stand density and its effect on wood quality

Wood Quality – What is it?

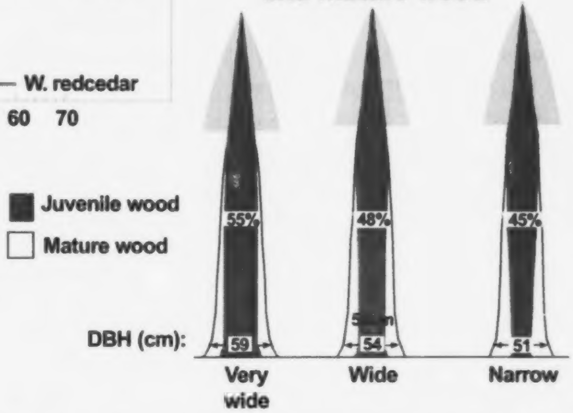
- It depends on the end product

What attributes are important?

- Attractive visual features?
- Dimensional stability?
- Bracing strength?
- Strength and stiffness?
- Ring width



Distribution of juvenile and mature wood



Juvenile wood
Mature wood
55%
48%
45%
DBH (cm):
59
54
51
Very wide
Wide
Narrow

Wood Quality

The interactions between basic tree and wood properties and species, seed source, geographic location, site conditions and management decisions are very complex.

- As a result, it is difficult to discuss these relationships in detail. However, an attempt is made in this section to outline the more important interactions in a general way so that foresters concerned with maximizing timber value are aware that silviculture decisions can affect both the tree volume and wood quality components of timber value. Tree and wood quality refers to specific characteristics that affect the value recovery chain from harvesting of trees to manufacturing and grade recovery of specific products (Zhang 1997).

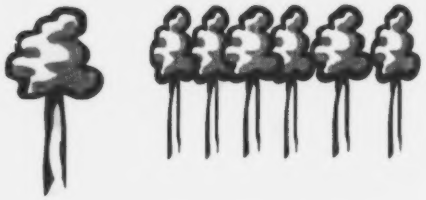
Wood quality characteristics depend on the intended products and are usually defined by relative wood density, ring width, microfibril angle, fibre length, knot size and distribution, spiral grain angle and chemical composition (e.g., lignin-cellulose ratios and extractives). Their affect on product quality and value have been discussed in detail by Jozsa and Middleton (1994).

The key issues that can be affected by treatment are:

- **Juvenile wood vs mature wood** – Juvenile wood is crown derived (and often less dense – see figure 12 in the guidelines). Thus the larger the crown the more juvenile wood. Wider spacing will result in more juvenile wood in each stem (e.g., 55% vs 45% in the example), but how much will depend on the species and spacing density and the time until harvest.
- **Knot abundance and size** – Will affect end use possibilities. Wide spacing will produce larger knots limiting the end products in some cases (e.g., strength and appearance).
- **Appearance** – ring width and consistency. Heavy entries will result in wide variation on ring width and could affect the esthetics of the product.

For more detailed information read *A discussion of wood quality attributes and their practical implications* by L. Jozsa and G.R. Middleton, 1994, Special Publication SP-34 (as suggested in the guidelines).

Density and Other Factors



Other Factors to Consider

Waste and Breakage

- **volume may not be recoverable – will technology offset these problems?**

Damaging agents

- **See Technology Transfer Note #12 for some guidance (both insects and disease).**

For example – in a tabular format this is presented

These insects – **e.g., Mountain pine beetle**

Affect these hosts – **Pine species**

And cause this type of damage – **kill apparently healthy trees...**

Thinning may affect it by – **modifying vigour, food base, climate...**

So forest managers should – **not thin when stands are under high stress, not thin stands prone to windthrow or high levels of disease, thin stands in late summer or fall after beetle attack...**

Density – Other Factors to Consider

Waste and Breakage

- Managing for high density produces more small slender (larger height/diameter ratio) stems than would occur in stands of lower stocking. These trees have a greater risk of breakage during harvest, and windthrow if left exposed by commercial thinning or partial cutting. Consequently, some of the "extra" volume contained in the smaller diameter classes of untreated stands may be lost to breakage, or not utilized because of size, particularly if markets are poor. These losses may be offset by technological changes in the future.

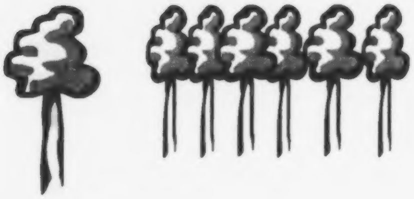
Damaging agents

See Tech Transfer Note #12 for some guidance on insect pests and forest diseases and their effects caused by thinning.

These insects	**Affect these hosts**	**And cause this type of damage**	**And may be affected by thinning because**	**So forest managers should**
Pine beetles	e.g., Pine	kill apparently healthy trees…	it affects host vigour, food base, stand climate and spacing	not thin in years of high stress not thin in stands prone to windthrow or have a high incidence of disease thin stands during late summer and early fall after the main beetle attacks. The inner bark looses its attractiveness to beetles the following year.

Similar information is presented for forest diseases.

Density and Other Factors



Other Factors to Consider

Wildlife habitat

Spacing can increase or decrease habitat values for different species.

For example:

Habitat quality decreased	Habitit quality unaffected	Habitat quality improved
Marten	Gray wolf	Coyote
Fisher	Grizzly bear	Black bear
Lynx	Ermine	Long-tailed weasel
		Cougar
		Bobcat

(From: *Stand Tending Impacts on Environmental Indicators*, 1996)

Density – Other Factors to Consider

Wildlife habitat

See references provided in the guidelines for more detail – spacing can increase or decrease habitat – it depends.

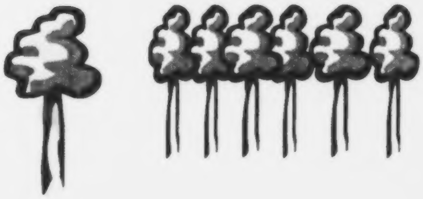
The table provided indicates 'in general' the effects of spacing on habitat quality for a range of carnivores found in interior BC. The example takes a pole sapling stand with 100% crown cover down to 25–65% cover. The classification takes into account both feeding and reproductive requirements.

Habitat Quality Decreased	Habitat Quality Unaffected	Habitat Quality Improved
Marten	Gray wolf	Coyote
Fisher	Grizzly bear	Black bear
Lynx	Ermine	Long-tailed weasel
		Cougar
		Bobcat

As this table shows habitat for a number of carnivores is unaffected or improved by canopy reduction. However:

As can be seen, there will be trade-offs created by using varying densities. Greenough and Kurz (1996) conclude their document with the need for landscape-level analysis. Where large scale treatments are contemplated, this is a must.

Density and Other Factors



Other Factors to Consider

Hydrology

- No effects of thinning identified to date.

Biotic and abiotic effects of spacing – ?

- more rapid decomposition
- possibly more respiration...
- more rapid movement of root decay inoculum

IN CONCLUSION...

BEWARE: Spacing can result in positive and negative consequences.

You should be aware of the possibilities *before* you start.

Density – Other Factors to Consider

Hydrology

No effects of thinning identified to date. The key is – likely time until crown closure. If this is affected dramatically (e.g., very wide or clumpy spacing) the recovery rate may be significantly reduced. Present density reductions have not been shown to affect hydrological recovery rate.

Biotic and abiotic effects of spacing

Many site and stand factors may be affected by stand density management practices; some may enhance the productive capacity of the stand, while others may introduce elements of uncertainty and risk.
For instance:

- Higher levels of sunlight and warmer soil temperature may influence micro-organisms and the rate of nutrient cycling.
- Increased micro-organism activity may increase the decomposition rates of slash remaining after thinning, and eventually improve mineral nutrient availability for the remaining crop trees.
- Reduced uptake by the stand may influence the diurnal and seasonal availability of soil moisture, thereby influencing the pattern of stomatal activity, duration of photosynthesis, and the rate of biomass production in the standing crop.
- Increased sunlight, warmer air temperatures and increased air movement may increase the respiration rate of the standing crop, partially offsetting increased biomass production rates.
- Cutting activity associated with thinning may increase the concentration and spread of root decay inoculum within the stand, resulting in greater losses of usable timber from the stand.

The characteristics of the site and stand may indicate the potential significance of these biotic and abiotic responses to density management decision making.

In Conclusion...

Beware – spacing can result in positive and negative consequences. You should be aware of the possibilities before you start.

As a parting word on biology and spacing effects – spacing is crown and gap management to achieve a desired result. Stay informed.

Lesson 4

Economic Principles of Timber Production

An Overview

45 minutes

Lesson Objectives

- To promote a common understanding of economic principles that are pertinent to silviculture investments
- To make participant's aware of the difference between stand level analyses and forest or estate level analyses.

Method: Introduce the Guidelines – Lecturette

- Go over the main sections outlined in the guidelines
- Provide a summary of Appendix 1 – Predicting Timber Values

Audio Visual Requirements

- Overhead projector

Handout

Spacing – When is it a good investment?

Key elements

- Objectives – Forest estate level objectives
- Time – Using discount rates and economic analyses
- Revenue/Value – Assumptions and information
- Costs – What to use
- Site Conditions – Growth potential – How to factor it into the analysis.

Economic Principles

We will go over the terms and methods used to evaluate the question – when is spacing a good investment?

The intent of this section is make you aware of the terms and key elements of an economic analysis.

- Objectives – Forest estate level objectives
- Time – Using discount rates and economic analyses
- Revenue/Value – Assumptions and information
- Costs – What to use
- Site Conditions – Growth potential –
  How to factor it into the analysis.

Each element will be discussed allowing time for questions and clarification.

Economic Principles

Objectives

Forest Estate or Stand – Which should I use?

The guidelines provide direction for stand level economic analyses

- **Forest Estate economic analysis is not covered by the guidelines.**

However...

- **Ideally, stand level analyses are used within Forest Estate Models to determine appropriate treatments – this is the intent for your local planning units.**

Objectives

Forest Estate or Stand – Which should I use?

The guidelines provide a production economics background for evaluating stand density management options.

- Production economics is the process of determining which, among all treatment options capable of meeting forest management objectives, will maximize the return on treatment investment for the forest estate owner.
- This approach is consistent with the philosophy that the purpose of stand density management is to achieve the timber and non-timber production objectives of a forest management plan.

These stand level economics principles are not intended to address social welfare objectives such as income distribution or employment creation.

Therefore to properly assess the economic value of a treatment regime it must be viewed in the context of the Forest Estate.

Thus the stand level economic analyses described in the guidelines are only an input to the more holistic forest estate level of assessment.

- It must also be stressed that the models used for Forest Estate planning are run by assumptions and provide imperfect views of reality. All results should be treated with caution and be used as an aid to decision making, not as the decision maker itself.

The treatment must fit within the Forest Estate strategy or treatments may go against the objectives for the area. Thus it is key to identify forest level objectives and weigh stand density decisions in that light.

Examples using present TSR data will be explored later in the session.

Economic Principles

Stand Level Assessments

Time – how is it accounted for?

Net Present Value vs Site Value

Which one where?

Treated vs Untreated
Net Present Value –

Different Regimes
Site Value –

$$SV = \frac{\sum_{i=0}^{A} R_i (1+r)^{A-i} - \sum_{i=0}^{A} C_i (1+r)^{A-i}}{(1+r)^{A} - 1}$$

$$NPV_u = (R_u - C_u - C_d + Sv_u) / (1+r)^{A-a}$$

$$NPV_t = R_c - C_c - C_d + (R_t - C_t + Sv_u) / (1+r)^{A-a}$$

Time – How to Account For It

We will go over the concept of density management as an investment, building on the text of the guidelines.

Information about the timing of stand activities is required, since various costs and benefits usually occur during different time periods over the life of a stand.

- Economic analysis converts all costs and benefits to value in today's dollars. This conversion process is referred to as discounting (see *Selecting a discount rate* on page 36). The net present value (NPV) is the sum of all discounted benefits of silvicultural activity or regime, less discounted costs.
- Regeneration costs such as site preparation and planting are incurred within the first few years, whereas density management costs are incurred between stand age 10 and 30.
- Final stand net revenues (revenue less harvest cost) are obtained at the end of the expected rotation period. The procedure for calculating the net present value of a density management treatment in a single stand is straightforward; the net present value of a juvenile spaced stand is compared to that of the same stand without spacing.

In order to make economic comparisons between different stands or different treatments, however, net present value must be calculated over the same time period.

- That is, for each present value, the starting point must be the same for each stand or treatment, and the end point must be the same expected rotation length. Since the timing of different stand treatments and the rotation lengths of different stands are rarely the same, it is often impossible to compare treatments and stands in this manner.
- In these circumstances, **the net present values must be converted to a site value (SV).**

The overhead shows a relatively complex equation that can be used to calculate the Site Value for a stand. In reality you will not likely hand calculate this value, instead it will be done for you in an economic model (for example the TIPSY economist).

A site value is the present value of an infinite number of successive rotations on a site managed under the same regime. An economic comparison of two or more stand management regimes is made possible by calculating and comparing the site value of each, even though they may differ in the timing of stand treatments or expected final harvest.

This type of analysis helps rank the economic attractiveness of treatment options.

For a treatment to be economic (have a higher SV or NPV) using time as a factor, the stand needs to grow value faster than the cost of treatment times the discount rate over the period between treatment and harvest.

This can be achieved by: obtaining more value at harvest through harvesting efficiencies, higher value products, mill efficiencies (fewer larger logs for the same volume) or greater lumber recovery factor. These conditions must add up to more than the cost of treatment carried over the time until harvest using the discount rate of the day. If the SV is not higher the treatment may still be beneficial at the Forest Estate Level, making it an option (described as a provisional option in the "Structured Decision Process").

Economic Principles

Revenue and Value

This is where we dust of the crystal ball.

Three key factors:

- ▲ **Valuation point**
- ▲ **Real price changes**
- ▲ **Relationship with piece size and price**

Revenue and Value

Assessing the economics of a proposed silvicultural activity requires information about:

- benefits and costs of the activity from the time of stand establishment to the time of expected harvest
- costs and benefits may be actual, if they have occurred, or expected if they are anticipated in the future.

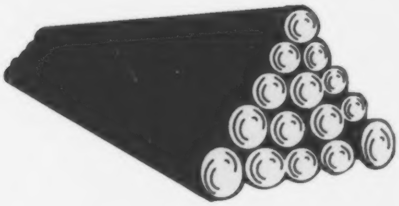
There are no guarantees with economic analyses, or all of our RRSPs would be twice what they are today!

There are some important factors and we will go over them to promote a common dialogue on revenue assumptions.

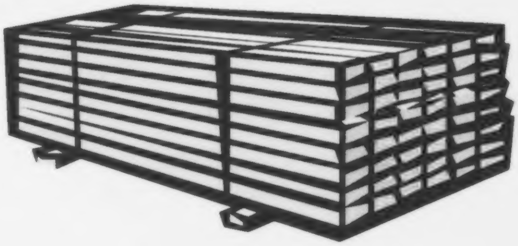
Economic Principles

Valuation Point

Coast



Interior



Valuation Point

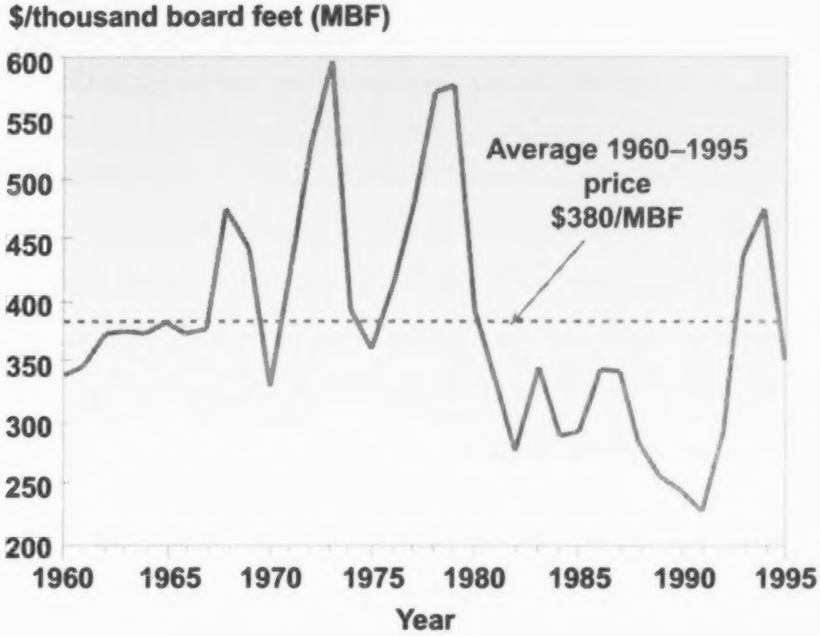
To allow valid comparisons some form of value or worth must be used.

For simplicity, the value of harvested timber can be derived from the selling price of manufactured end-products. A common practice is to evaluate the timber as it moves up manufacturing stages to a point where a market price for a product can be determined. At that point any wood quality differences that affect the product are reflected in the price.

- In the coastal region of British Columbia the end-product values are derived from log transactions on the Vancouver Log Market (Ministry of Forests, 1995b).
- In the interior, where log markets are uncommon, a market value is derived from processed lumber and residual wood chips (Ministry of Forests, 1995a).

Economic Principles

Real Price Changes



No clear trends emerge in real lumber prices in constant 1995 Canadian dollars

Supply* and *Demand* are the *Drivers

CAUTION IS ADVISED

Real Price Changes

A word of caution – lots of factors are involved.

The graph shown (Figure A1-2 from Appendix 1 of the guidelines) shows trends in real lumber prices in constant 1995 Canadian dollars (western spruce–pine–fir, kiln dried, standard and better, 2×4, random length lumber). It indicates the volatility surrounding price.

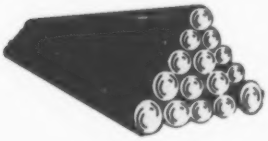
Conclusions and recommendations

Time in and of itself has no effect on prices, and past prices do not dictate what future prices will be. Market supply and demand forces, which change over time, are what cause prices to change. Use of simple trend models to predict future prices assumes that forces of supply and demand that caused the past price changes are closely correlated with time and that this correlation will continue into the future. This assumption is simplistic, and warrants caution in the use of models based on similar logic.

Economic Principles

Long Run Price Increases

Coast



Real price increase forecasts for logs from the coastal region

Forecast period (years)	Tree species (% price increase/year)			
	Douglas fir	Cedar	Hemlock	True firs
1990–00	1.4	3.8	0.2	0.8
2000–10	0.1	-0.7	-0.6	-0.2
2010–20	0.4	0.5	0.1	0.3
2020–30	0.1	0.3	0.1	0.1
2030–40	0.1	0.3	0.1	0.1
Average	0.4	0.9	0.0	0.2

Source: H.A. Simons Strategic Services Division and Cortex Consultants [1993].

Caution is the key – note the relatively flat long-term forecast

It is recommended to look at other forecasts. Your species mix and product potential may be unique and vary from this estimate.

Long-run real log price increases

The table shown is Table A1-1 from Appendix 1 of the guidelines.

The most notable part of the information presented is the lack of long-term price increases from any of the species identified.

However, the footnote states:

It should be noted that these data are presented only as an example of forecasts typical of the range of values found from a number of recent analyses. They should not be considered the only, or the most accurate forecast of timber prices increases available. See also Feltham and Messmer, 1996.

Having said that the guidelines recommend:

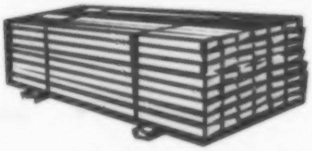
- **Given the factors which mitigate against real price increases**, it is appropriate to **select a conservative estimate of future real price increases.**
- The estimates presented in the table are examples of those typical within the range of most estimates. They are not unreasonable, especially if limited to the 50 year time period shown.

However, it is recommended to look at other forecasts, your species mix and product potential may be unique and vary from this estimate.

Economic Principles

Long Run Price Increases

Interior



Default lumber and wood chip prices used in the TIPSY ECONOMIST (constant 1995 dollars)

	Lumber ($/MBF)				Wood Chips
Species	2×4	2×6	2×8	2×10	($/BDU)
Fdc	455	460	455	560	110
Pl	380	369	376	452	110
Hw	406	406	414	491	110
SS	380	369	376	452	110
Cw	482	482	583	583	15
Sw	380	369	376	452	110
Fdi	426	430	439	554	110

Source: Stone *et al.*, 1996.

These values are used in the TIPSY economist and may provide reasonable long-run estimates

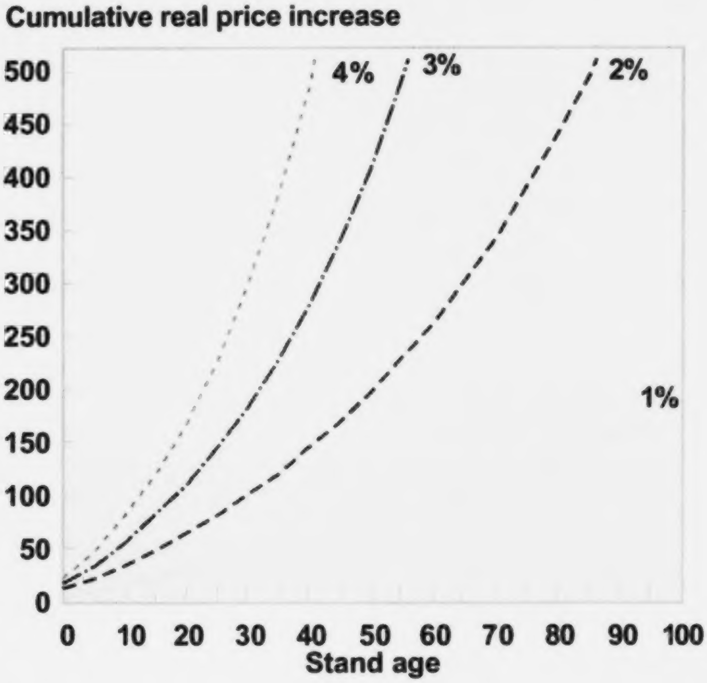
Long-run real lumber and chip prices

The table shown is Table A1-2 from Appendix 1 of the guidelines.

- The guidelines suggest the real lumber and wood chip prices presented in Table A1-2 may provide reasonable long-run estimates (Stone *et al.*, 1996).
- The long-run real price of 2×4 lumber for each species is the average for the periods studied, while the price for other dimensions is a function of the 2×4 price and the average price ratio of dimension lumber to 2×4 lumber.

Economic Principles

Long Run Price Increases



Real Per Annum Price Increases – A Word of Caution

Given the lack of any clear trend in past real lumber prices (as indicated in Figure A1-2 [OH 4.6]), and the likelihood of only modest real price increases for logs in the future, caution is warranted in making future value assumptions when evaluating the economic efficiency of silvicultural investments.

- For example, the overhead illustrates the cumulative effect of annual real price increases of 1%, 2%, 3%, and 4%.
- If these annual price increases were compounded over a period of 75 years, as they might be in an analysis of juvenile spacing for instance, the resulting cumulative increase in timber value would be 111%, 342%, 818% and 1795%, respectively.

The significance of these extremely high future values is considerable in the calculation of net present value or site value of a stand density management investment analysis.

The compounding effect of an assumed annual price increase can be reduced by limiting the period over which the compounding takes place.

- For example, an assumption of a 1% per annum real price increase over the first 25 years with no real price increase thereafter results in a cumulative real price increase of only 28%.

The figure used is from Appendix 1 (Figure A1-9) of the guidelines.

This is why you want to invest early in your RRSP! (or is it too late?)

Economic Principles

Harvesting Costs

How does density management affect costs of the various harvesting phases?

Fixed costs	No change
Tree to truck	Less – fewer stems yarding the biggest factor
Log haul	Less – fewer stems

See Stone 1996 articles and the *Appraisal Manual* for help.

Harvesting costs

Harvesting costs can be categorized by harvesting phase, such as road and site development costs, tree-to-truck costs (felling and yarding), log haul costs (loading, truck haul, towing, or barging), and administration and overhead costs. The effects of density management on each cost phase must be accounted for in any analysis.

Development, overhead and administrative costs are examples of fixed harvesting costs.

- Density management treatments that result in changes to the volume of timber produced by a stand will not affect total fixed harvesting costs, but will affect the average fixed costs per cubic metre of timber produced.

Density management treatments have a larger impact on certain components of tree-to-truck and log haul costs, which are examples of variable costs.

- For instance, log haul costs are influenced primarily by changes in loading time resulting from the number of logs required to complete a load. However, the cost of the loading component of log haul costs is relatively small.
- Density management practices have greatest impact on tree-to-truck costs, particularly the yarding component.

For further information on more detailed aspects of harvesting costs, refer to the Ministry of Forests *Appraisal Manuals* (Ministry of Forests, 1995 (a and b) as well as Stone (1996 a and b).

Harvesting costs can be inserted into the TIPSY economist to approximate local conditions. Appendix 2 in the guidelines provides a sensitivity analysis to indicate where the "break-even" point of treatment occurs by varying harvesting costs.

For example, how much of a difference in tree-to-truck costs is required to equate the returns from the thinned and unthinned stands? Or, at what harvest cost does the net economic gain from thinning equal zero? And, how does it differ from the tree-to-truck costs used for the unthinned stand?

Economic Principles

Future Harvest Costs

Tree-to-Truck – Working With the Numbers

Use TIPSY economist to 'game' harvest costs – an example is spelled out in Appendix 2 of the guidelines.

Example

- **Discount the cost of spacing to year zero ($660 at 17 years = $339 at year zero).**
- **Set thinning costs to zero and reduce tree-to-truck costs until the site value between the two regimes at the economic rotation (age 80) in the example matches the discounted spacing cost ($339 in this case).**

Tree to truck costs need to be $9.90/m^3 compared to $14.36 used by the model.

Is this a reasonable cost?

Future Harvest Costs

The guidelines provide the following example that you may wish to lead the group through.

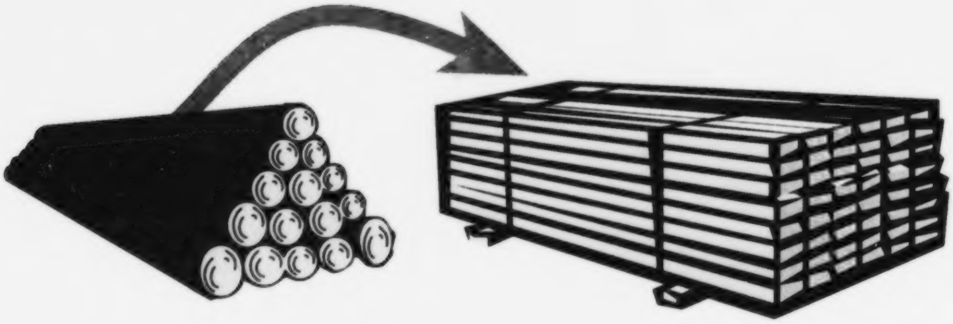
Consider two coastal hemlock stands at an economic rotation age of 80 years. One is unthinned and the other is thinned to 900 trees/ha. Thinning costs are $660 at age 17, which discounts to $339 at age zero. This is the amount by which the site value of the thinned regime must exceed that of the unthinned regime to offset the cost of treatment. The average default tree-to-truck costs in TIPSY are similar (\$ 14.36/m^3 Vs \$ 14.43/m^3) for the two regimes.

- Set the thinning costs to zero as in the preceding example and reduce the tree-to-truck costs of the thinned stand in small increments using the "Constant Cost" option until the difference in site values between the two regimes at age 80 matches the discounted spacing cost of $339.
- Table A2-8 shows that treatment would have to reduce tree-to-truck costs from \$14.36 to \$9.90/m^3 for a savings of $4.46.
- That is, it would be justified economically to thin the stand to 900 trees/ha if it reduced the average tree-to-truck costs by 31% relative to the unthinned stand assuming no increase in end product value.

Go over the results of the example and provide some closure.

Economic Principles

Milling Costs



Used for Interior Runs

For more information see Stone (1996a) and Stone *et al.* 1996.

Points to ponder

- **Lumber recovery is greater with larger logs**
- **Logs with a 10 cm top cost 70% more to mill than logs with 40 cm tops**
- **Stumpage deducts the difference**

Milling costs

The guidelines provide the following information:

Coast

- Milling costs need not be accounted for in economic analysis based on log values, since the log prices used in the analysis should already reflect differences in milling costs.
- However, when the analysis is based on lumber and wood chip end products, the effects of density management treatments on milling costs must be accounted for.
- Larger log sizes result in lower milling costs, although other factors, such as log taper, must also be considered. Stone (1996a), and Stone *et al.* (1996) illustrate a method for predicting changes in milling costs.
- Lumber Recover Factor appears to play a significant role in milling costs.

Stone in *An Economic Analysis of Lumber Manufacturing Costs in the Interior of British Columbia* WP-6-014, 1996c provides the following:

By using formula suggested by Stone (1996c) an estimated cost of milling can be created.

Average Total Cost Function $ATC = 2234.31\ LRF^{-0.5199}$

or

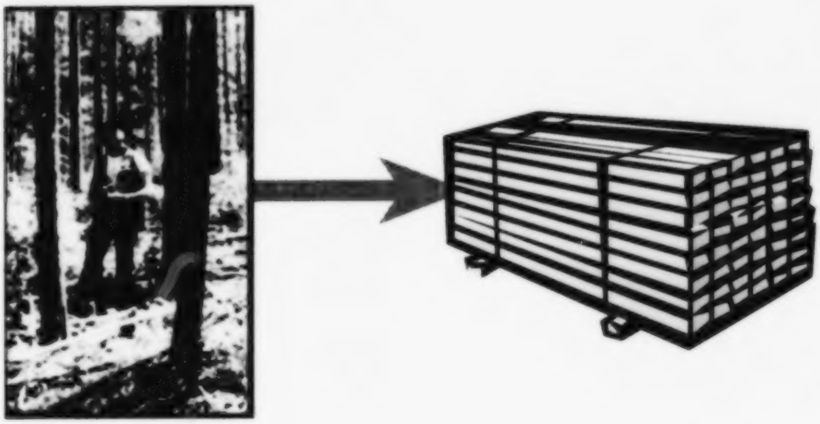
Average Total Cost Function $ATC = 422.66 - 2.0521\ LRF + 0.003418\ LRF^2$

- What this does is provide a cost of milling that relates to the diameter of the input logs.
- Using a top diameter of 10 cm provides a LRF of approximately 150 board feet per cubic metre.
- A log with a top diameter of 40 cm has a LRF of about 230 board feet per cubic metre.
- These relate to $220/MBF milling cost to about $130/MBF or about 70% increase in milling costs for the small dimension lumber.

NOTE – The interior stumpage appraisal system derives the value of standing timber by deducting all harvesting, transportation, and manufacturing costs from the value of lumber and chips from the stand. Therefore higher milling costs for small dimension wood result in reduced stumpage payments for the stand.

Economic Principles

Silviculture Treatment Costs



Treatments

Cost will affect your economic analysis

- **Cheaper treatments will look more attractive**
- **Local market will dictate – use local numbers when available**
- **Later treatments are more attractive than early ones**
- **Treat when biologically optimal**

Silviculture Treatment Costs

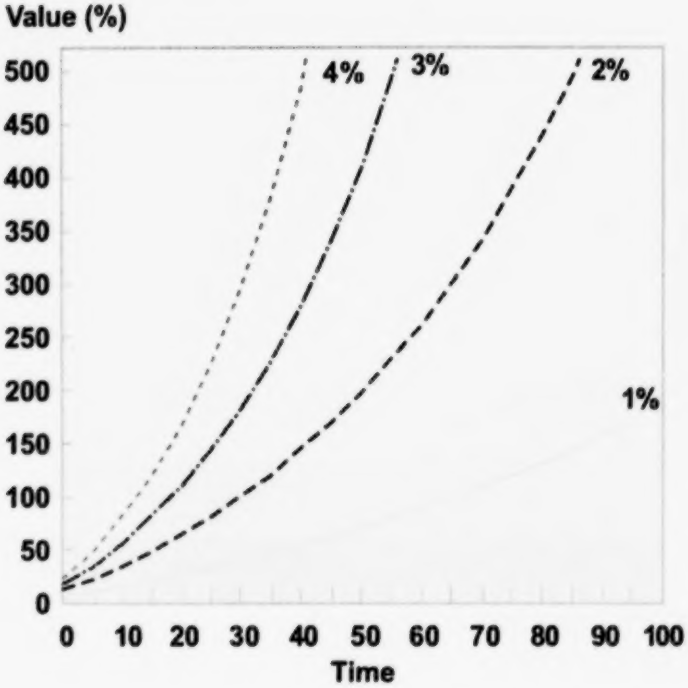
The guidelines provide the following information:

The cost of stand density treatments is usually a function of site and stand conditions such as:

- road access and travel distance,
- the average slope of the site,
- original stand density,
- the number of trees removed, and
- the average height and diameter of the trees removed.
- Local labour market conditions may also influence treatment prices.
  - For instance, the number of silviculture operators available to bid on a project and the amount of work currently under contract may have a substantial effect on treatment prices.
  - **Local market treatment costs should be used to assess density management options. If this information is unavailable, regional average costs may be used.**

Economic Principles

Selecting a Discount Rate



What about 4%?

Government used real rate – inflation factored out.

Selecting a Discount Rate

The guidelines provide the following information:

Silvicultural investments are characterized by treatment costs and benefits which occur in different time periods through the rotation. These costs and benefits must be converted to present values in order to assess investment efficiency.

- ▲ The purpose of a discount rate in an economic analysis is to reflect the preference that societies, organizations, or individuals have for present, versus future consumption.
- ▲ **Income received, or costs incurred today are considered to be worth more than income or costs which occur in some future time period.**
- ▲ The rate of discount is used to determine how much less future revenues or expenditures represent in today's dollars. Discounting permits a comparison of various flows of benefits and costs occurring over time in a consistent and logical manner.

Choice of a discount rate is influenced by markets for capital, opportunity costs of capital, risk, and perceptions of risk, uncertainty, inflation expectations, differences in the rate of borrowing and lending, as well as other factors.

- ▲ Governments and private sectors are both influenced by these factors, however private sectors of the economy are affected to a greater degree due to uncertainties in future product demand, natural resource conservation policies, and the wider range of alternative investment opportunities available.

Heaps and Pratt (1989), in *The Social Discount Rate for Silvicultural Investments*, estimated the discount rate using the social opportunity cost of capital for public sector investments in Canada, and found a range of between 3 and 7%, depending on how risk and uncertainty are accounted for. They argued that a risk-free rate should be used for silviculture investments, and recommended a discount rate of between 3 and 5%.

The Ministry of Forests uses a 4% real rate of discount for public sector forestry investment analysis. The discount rate, whether public or private, is a "real" discount rate. This means that it does not include any inflationary expectations. Inflation is "netted out" of a real discount rate since it is assumed to affect both costs and prices equally over time.

Whatever discount rate is selected, it must be used consistently for all silvicultural treatments. For example, although a lower discount rate would "improve" the economics of juvenile spacing, it would also reduce the benefits derived from commercial thinning. The discount rate is clearly a two-edged sword.

Economic Principles

Sensitivity Analysis

An Important Step

This can be used to "game" future values and costs as well as assessing "how robust" the analysis is.

The importance of sensitivity analysis

Sensitivity analysis is an important analytical method used to evaluate the effects of risk and uncertainty in economic analyses.

- Sensitivity analysis involves re-calculating the site value of a silvicultural treatment using a range of values around key factor assumptions.
- Key factors in an economic analysis include, future revenue, harvest cost, milling costs, silviculture costs (regeneration, tending, protection, administration) and investment period (rotation length).

For example, a sensitivity analysis of future harvesting cost would involve repeating the economic analysis using harvesting costs that are slightly higher and slightly lower than the expected value.

- The usual approach is to test values within plus and minus an arbitrary percentage (e.g., 10%) of the expected value.
- The sensitivity analysis is performed while keeping all other key factors constant.

The three site values from the sensitivity analysis (base case, -10% and +10%) are then compared; large differences indicate that site value is "sensitive" to small changes in harvesting cost.

Sensitivity in one or more key factors suggests that the economic analysis is not robust, and may lead to errors of interpretation. The outcome of the sensitivity analysis will determine whether all input values and assumptions should be re-evaluated.

An example from Appendix 2

The example analyses were based on the assumption that real end-product prices remain constant over time (i.e., wood products will not change relative to the cost of production). Under this assumption, juvenile spacing show no net gain in value over no treatment. This leads to the question,

- "How much of an increase in end-product price is required to cover spacing costs?"
- Assume the landowner expects that real end-product prices will rise steadily for the next 25 years and remain constant thereafter.
- What rate of increase is necessary to make the thinned stand as financially attractive as the untreated stand assuming all other costs and values remain constant?

To calculate this "break-even" price increase, discount the cost of thinning ($598) from age 16 to zero at 4%. This amounts to $319, which is the net gain in site value at age zero needed to cover treatment costs.

Set the cost of thinning to zero, and then elevate the "Real Price Increase" in small steps for both stands until the site value of the thinned stand exceeds that of the untreated stand by $319 at age 60. An increase of just over 2.6% is needed to cover spacing costs. Note that a 90% total increase in price results from the 2.6% price increase over 25 years. **This type of analysis can be used as a "reality check."**

Remember – site growth potential has a major influence on economic analyses as tree growth is geometric as is compounding interest. Good sites can keep up with discounted costs.

The most important assumptions affecting the economic analysis are:

- ▲ **discount rate**
- ▲ **real price increase**
- ▲ **site index (growth potential)**

Lesson 5

Forest Planning Considerations

An Overview

45 minutes

Lesson Objectives

- To identify the level of detail out there in higher level plans.
- To provide guidance on how to use the higher level direction available.

Method: Introduce the Guidelines – Lecturette

- Go over the main sections outlined in the guidelines
- Begin the linkage to the "Structured Decision Process"

Audio Visual Requirements

- Overhead projector

Handout

In participant's workbook

Why a forest level strategy?

Points to ponder:

- ▲ The road to nowhere in particular can be a windy one.
- ▲ If we treat a block to reduce its rotation length and yet have no need for the result at the forest level is it still a block?

Forest Planning Considerations

The road to nowhere in particular can be a windy one.

If we treat a block to reduce its rotation length and yet have no need for the result at the forest level is it still a block?

What are these questions referring to?

Stand-by-stand silviculture often assumes that a series of individual stand treatments results in an additive impact on resource supply at the forest level. Baskerville (in Kelty *et al.* 1992) warns that the effects of stand-level actions are usually not additive at the forest level. He suggests that stand-by-stand silviculture ignores the complex interaction of factors influencing resource supply, and reduces the likelihood of successfully controlling forest dynamics to achieve management objectives. For example, harvest flow considerations may force the advance or delay of harvests from the planned harvest ages that would have maximized the gain from a particular treatment. Thus the expected yields from stand-level planning may not be realized at the forest level.

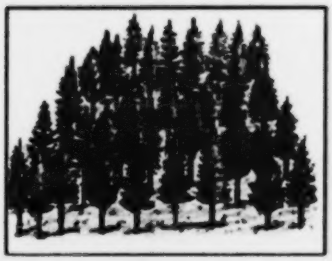
- A forest management strategy should be the guiding reference for stand-level silviculture (Reed and Baskerville1990).
- The relative "goodness" of a silvicultural intervention is difficult to judge unless viewed within a strategic context.
- In this context, even basic silviculture expenditures are difficult to evaluate objectively, except in terms of discharging legally binding reforestation obligations.

A comprehensive forest management strategy is therefore necessary before rational choices of stand-level interventions can be made. For example, without a strategic context, local stand density management interventions may result in:

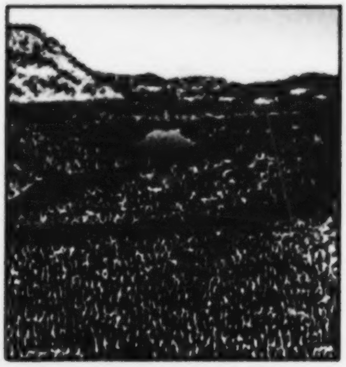
- inappropriate amounts or types of silviculture investments being implemented
- cumulative forest-level effects that exacerbate a forest management problem
- large opportunity costs if actual forest management problems are ignored.

The purpose of this section is to describe the forest-level context within which stand-level density management decisions are made. Specifically, this section examines the nature of forest-level objectives, their relationship to higher level plans, the strategies developed to meet those objectives, and how these strategies govern the selection of stand density management activities.

Forest Planning Considerations



Stand



Forest Estate

A couple of definitions:

Stand:	A homogeneous and distinguishable unit of a relatively uniform group of trees (opening type size).
Forest Estate:	A collection of stands, administered as a unit. In BC they are sustained yield units – TFLs, TSAs and woodlot licences

Forest Planning Considerations

A couple of definitions

There may be some confusion surrounding the term *forest estate*. To clear it up, here are the definitions provided in the guidelines.

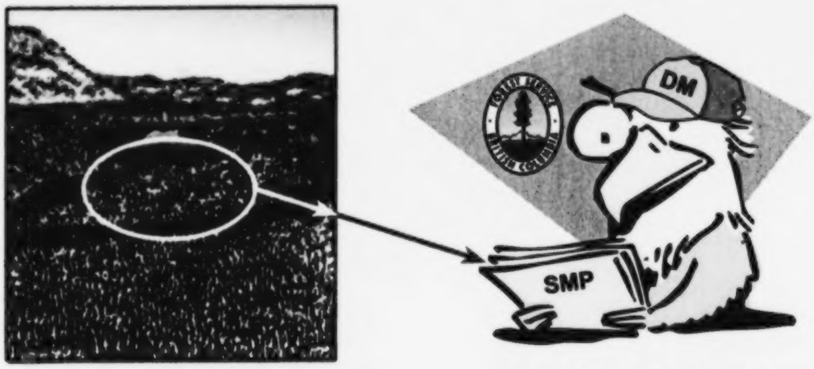
Not to dwell on them, but:

A stand – A contiguous group of trees sufficiently uniform in species composition, arrangement of age classes, and condition to be a homogeneous and distinguishable unit.

A forest estate – A collection of stands, of varying types, ages, etc., administered as an integrated unit and managed for some continuity or flow of harvest volume. For the purpose of this document, the forest estate is synonymous with the *sustained-yield unit* which includes timber supply areas, tree farm licences and woodlot licences.

Forest-level objectives – Objectives established for the forest estate.

Forest Planning Considerations



Forest Estate Planning   Stand Level Planning

Linkages between Planning Levels

Guidance from Estate to Stand – See Code plans

Timber –	no perfect sources – best available – likely TSR and supporting documents
Non timber –	again – may be in 'higher level plans' but TSR a good starting point
Employment –	found in LRMPs and other forest level plans

Forest Planning Considerations

Linkages between levels of planning

Higher level planning, as used in forest management in BC today:

- refers to the hierarchical system of planning established under the *Forest Practices Code of British Columbia Act* (the Code).
- Under the Code, the following hierarchy has been established,
  - where the highest level of plan is objectives for resource management zones,
  - followed by objectives for landscape units,
  - objectives for sensitive areas, and objectives for interpretive forest sites, recreation sites and recreation trails.

In a hierarchical planning process, higher level plans guide plans lower in the hierarchy. For example, objectives established for a landscape unit are guided by the objectives established for a resource management zone. The Code also stipulates that operational plans, such as stand management prescriptions (which may include density management activities), must be consistent with higher level plans.

At the same time, actual operational conditions provide guidance to the levels higher in the hierarchy. For example, planning delays or limits in budgets or other resources may result in amendments to plans higher in the hierarchy.

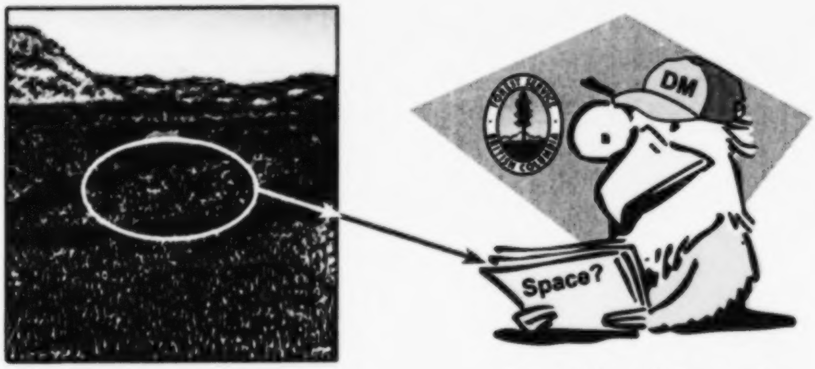
Forest-level objectives, which will guide stand-level activities, are embodied within resource management zone objectives and landscape unit objectives for all Crown land, and within management plans for TFLs and woodlots.

- For more information on higher level planning, refer to *Higher Level Plans: Policy and Procedures* (B.C. Min. For. 1996b) as well as *A Guide to Landscape Unit Planning* and *A Guide to Writing Resource Objectives and Strategies* (B.C. Min. For. 1998).

Guidance on timber, non-timber and employment are needed to guide stand-level treatments.

Sources of information include the Code plans in place as well as Timber Supply Reviews and TFL Management plans.

Forest Planning Considerations



Forest Estate Planning

Stand-level Planning

Objectives, opportunities and options

Find out what you need and determine what will help you achieve it.

- Spacing may not create the desired conditions to achieve what you need!
- Identify Strategic Silvicultural Opportunities to meet your needs!
- Monitor and adapt accordingly!

Forest Planning Considerations

Objectives, opportunities and options

This is pretty straightforward – once you identify what you are trying to achieve, try to match that with your opportunities and options.

- ▲ Stand density management is only one of a number of possible silviculture practices capable of influencing forest-level factors.
- ▲ **Any stand treatment which contributes to the achievement of forest objectives is a silvicultural opportunity.**
- ▲ The structure (e.g., species, age class distribution, density) and site quality of the forest estate and the complexity of management objectives are the major determinants of **silvicultural opportunities.**

These may require silviculturists to consider a wide variety of treatment or regime options to satisfy management objectives.

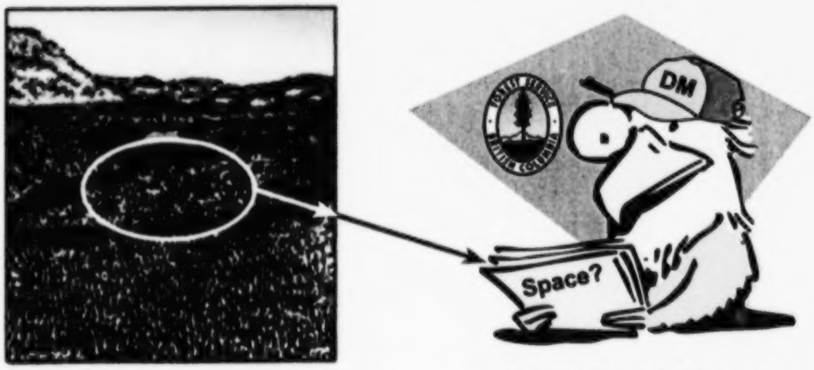
- ▲ Once density management opportunities have been identified, and stand treatment options have been selected and implemented in the forest, the biological effects should be evaluated periodically and compared with expected responses. Actual departures from expected results may require reconsideration of the silviculture options, opportunities or both. This adaptive density management approach encourages continuous validation of assumptions, and incorporation of new information and experience.

REMEMBER

What does spacing do? – Grows fewer trees faster, provides open space for non-crop vegetation to grow, creates employment.

The rest depends on opportunities – what stands are available, what age, what site potential, where are they and the like.

Forest Planning Considerations



Forest Estate Planning

Stand-level Planning

Steps in identifying strategic silvicultural opportunities

1. **Obtain and assess existing forest-level analyses.**

If needed...

2. **Conduct additional forest-level modeling analysis.**

How do I Identify Strategic Silvicultural Opportunities?

Go over the following points

- Identifying silviculture activities which assist the meeting of forest-level objectives requires, at least, an assessment of existing information pertaining to the forest level.
- Note – It may stop there.
- Forest-level modeling is neither necessary nor recommended if there are sufficient materials and expertise available to formulate silvicultural opportunities.

Use experts when available

It is recommended that the identification of silvicultural opportunities which help meet forest-level objectives follow a two-step process:

1. **Obtain and assess existing forest-level analyses.**
2. **Conduct additional forest-level modeling analysis.**

The first step is essential. Completion of the second step may not always be possible, nor is it always necessary.

For each, an understanding of forest-level concepts is important, and it is recommended that expertise in forest-level concepts or forest-level modeling be sought, where necessary.

To better understand silvicultural opportunities for your forest estate,

- review all relevant existing materials.
- You can expect this review to provide useful insights and possibly sufficient information for identifying strategic silvicultural opportunities.

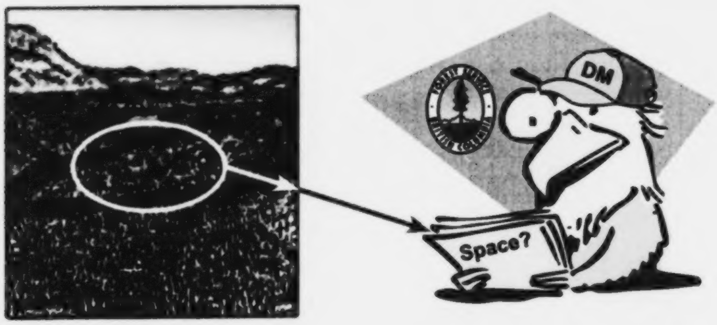
The results of the most recent TSR timber supply analyses and the AAC rationales provide a rich source of information on forest-level objectives, at least those perceived to impact timber supply.

An especially valuable section of the timber supply analysis document describes the sensitivity of the forecast harvest flow to changes in key variables, some of which might be affected by density management decisions.

- ▲ **For example, the TSR timber supply analysis may note that short term timber supply is increased substantially if the minimum harvest age is reduced by five years.**
- ▲ **This might be interpreted as an opportunity to use density management to decrease the age at which high value forest products (e.g., sawlogs) can be obtained from the stand.**
- ▲ **In addition to reviewing documents, spreadsheet models that incorporate timber supply sensitivity analysis from the TSR can be useful for estimating the impact of stand density management activities on short- and long-term timber supply.**

We will go over an example in the next section – A structured decision process.

Forest Planning Considerations



Forest Estate Planning Stand-level Planning

Forest-level Modeling

Three important considerations for regimes designed to impact timber supply:

1. **Consider AAC determination when making decisions**
2. **Consider the desired harvest flows for the entire SYU**
3. **The future is uncertain – treat the results with caution and use only as an aid to decision making**
   – Thinking is still required

Forest-level Modeling

Go over the following points briefly – discuss the need to use qualified people on your team to get reliable results.

Forest-level modeling is an analytical process that will assist the identification and quantification of strategic silvicultural opportunities.

- ▲ A forest-level analysis may help determine a set of silvicultural regimes that best meets the combined objectives, subject to harvest flow requirements and forecast silviculture budgets.
- ▲ This set of regimes constitutes the strategic silvicultural opportunities for the forest.

Forest-level models can help determine the sensitivity of the forest-level objectives to each strategic silvicultural opportunity. This information may be used in the process of allocating funds to projects.

Any such modeling exercises undertaken should be integrated with other exercises such as those being conducted as part of formal planning processes.

- ▲ In the guidelines Table 3 in "Density management planning tools" lists commonly available forest estate models.
- ▲ Often a considerable investment of time and resources is necessary before operators acquire the necessary experience to be able to use such models competently. An alternative is to make use of services available within and outside the Forest Service.

Three important considerations need to be made when conducting forest-level analyses for the purpose of assisting the determination of silvicultural regimes that are designed to impact the timber supply for the forest estate:

1. Assumptions should be consistent with, and follow from, those made in timber supply analyses supporting AAC determinations.
2. Forest-level analyses should consider the desired harvest flows for the entire forest estate or sustained yield unit, rather than for a sub-unit only.
3. Little is known about the future with certainty, and models provide imperfect views of reality. All results should therefore be treated with caution and be used only as an aid to decision making not as the decision maker itself.

We will go over the Structured Decision Process now.

Lesson 6

A Structured Decision Process

An Overview

60 minutes

Lesson Objectives

- ▲ To introduce the participants to the main components of the a structured decision process for making density management decisions.
- ▲ To emphasize the need for feedback and reevaluation.

Method: Introduce the Guidelines – Lecturette

- ▲ Go over the main sections of the structured decision process,
- ▲ Provide a real life example

Audio Visual Requirements

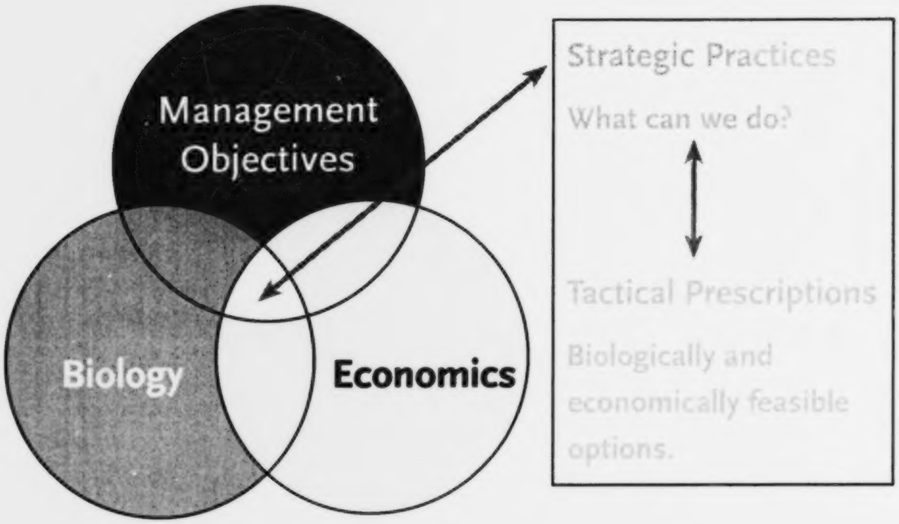
- ▲ Overhead projector

Handout

In participant's workbook

Baskerville article

Structured Decision Process



Management Objectives

Biology

Economics

Strategic Practices

What can we do?

Tactical Prescriptions

Biologically and economically feasible options.

Decision Process – Management Objectives

Some possible sources for guidance:

- **Timber Investment Steering Committee**
- **Innovative Forest Practice Agreements**
- **TFL management plans**
- **TSA Timber Supply Review**

A Structured Decision Process – Management Objectives

The knowledge required to make density management decisions is similar to that required for other silviculture decisions. For example,

- a silviculture planner must understand the requirements and objectives of the forest owner,
- the characteristics of the forest and
- the response potential of individual stands within the forest to specific management interventions

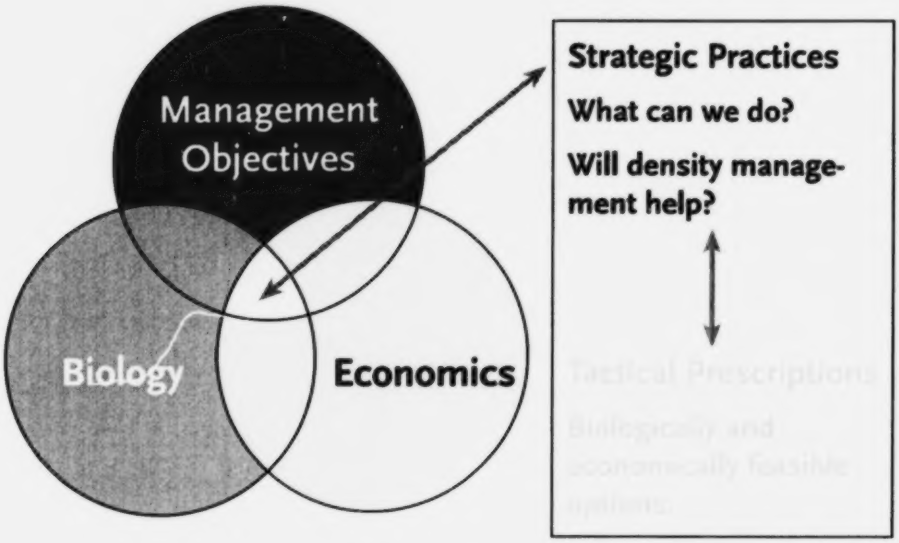
The decision framework consists of three major components. First and foremost:

- Management Objectives
- Management objectives define the current and future quantity and quality of timber and non-timber resources desired from the forest. For instance, management objectives should specify:
  - the silvicultural system(s) to be employed,
  - the periodic rate of timber harvest, the species to be managed,
  - the standards defining current and future harvesting operability, and
  - current and future product objectives.
- Non-timber resource objectives require similar detail. For instance, biodiversity, habitat, recreation and visual management objectives should be defined in space and time parameters, including specified areas, specific locations, management periods and standards defining the kinds of management interventions permitted.
  - Defining management objectives for public forest resources is a complex process. Factors such as the nature and extent of the forest resources available, the goals of each resource user, and the resource management rules imposed by governments must be harmonized into a single, acceptable forest management plan. The process of defining forest management objectives is beyond the scope of this document.

Some possible sources for guidance:

- Timber Investment Steering Committee
- Innovative Forest Practice Agreements (Lignum Merritt)
- TFL management plans
- TSA Timber Supply Review

Structured Decision Process



Strategic Practices

What can we do?

Will density management help?

Tactical Prescriptions

Biologically and economically feasible options

Decision Process

Prerequisites for a forest-level strategic analysis are:

1. **Clear and specific forest management objectives**
2. **Accurate information on the growing stock of the forest**
3. **Knowledge of the potential benefits of the potential treatments**

A Structured Decision Process

Strategic Practices

Management plan objectives and the structural and productivity characteristics of the forest estate will determine which silviculture strategy (forest practice) to pursue.

Thus to identify strategic practices one must first describe the forest estate. Once the forest estate has been described, for example by species, age and productivity it can be analyzed to determine what if any strategic practices could be used to assist achieving the objectives for the unit.

The strategic value of reforestation, density management, fertilization and pest management can be determined through analysis, usually involving forest estate modeling. There is a list of commonly available decision support and forest estate models provided in the guidelines, (pp 49–53). To use the tools effectively requires someone who knows what they are doing.

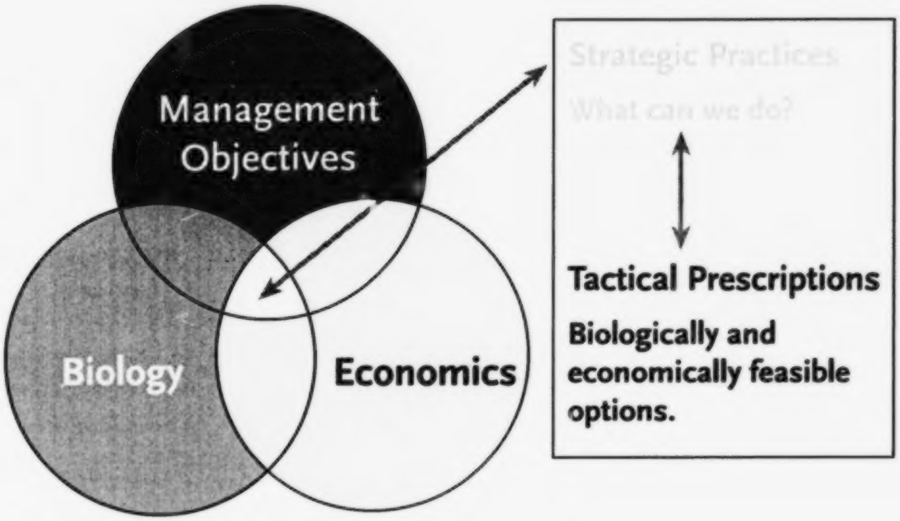
Prerequisites for a forest-level strategic analysis are:

1. clear and specific forest management objectives
2. accurate information on the growing stock of the forest
3. knowledge of the potential benefits of a wide range of silviculture practices.

More than one strategy may be necessary to accomplish management objectives. A thorough analysis will indicate relative strategic values, (e.g., brushing vs thinning), as well as the scale of silviculture activity necessary.

We will go over an example once we have covered the third component of the decision framework.

Structured Decision Process



Strategic Practices

What can we do?

Tactical Prescriptions

Biologically and economically feasible options.

Decision Process

Tactical prescription to create premium logs (Fd SI32)

- ▲ Space to 600 sph at 4 metres average height
- ▲ Prune one lift when dbh is between 5 and 8 cm (5–7 m tall)
- ▲ Prune second lift when height is betwen 9–12 m
- ▲ Harvest at 80 years

A Structured Decision Process

Tactical Prescriptions

Stand-specific silviculture treatments are tactical decisions. Stand-level tactics (silviculture prescriptions, stand management prescriptions) should support silviculture strategies. Prescription design and treatment effectiveness must be viewed within the context of the strategic plan.

The key point here is that stand density prescriptions must be made within the context of a broader silviculture regime, and a silvicultural regime must be guided by the strategic objectives for the management unit.

A definition:

Silvicultural Regime – A series of carefully sequenced and implemented activities at specific time periods and intensities to achieve desired objectives.

For example, to create premium sawlogs on good sites.

Here is an hypothetical tactical prescription:

- ▲ Space to 600 sph at 4 m
- ▲ Prune one lift when dbh is between 5 and 8 cm (5–7 m tall)
- ▲ Prune second lift when height is between 9–12 m

Harvest at 80 years.

Key points:

Tactical prescriptions must be in line with the strategic objectives of the management unit.

There must be sufficient stands to make it worthwhile at the forest level.

Treatment regimes must be either suitable or provisional, based on the project planning matrix.

Structured Decision Process

Project Planning

Some examples using the three levels of feasibility

Decision criteria	Expected outcome of forest and stand analysis				
Biological feasibility	+	+	+	+	+
Economic feasibility	+	+	+	−	−
Forest-level feasibility	−	/	+	+	/
Stand-level treatment decision	Unsuitable	Prov.	Suitable	Prov.	Unsuitable

A Structured Decision Process

Project Planning

Three decision criteria must be considered: biological feasibility, economic feasibility and forest-level considerations. Biological and economic feasibility are based on a timber production perspective. Forest-level feasibility is a test of whether the treatment or project contributes to forest-level considerations, including both *timber* and *non-timber* objectives.

The test of biological feasibility is the most important of the three feasibility tests. Any treatment objective which is biologically infeasible for any reason must not be considered further. Forest resource stewardship also demands that silviculture practices should not compromise the structural integrity or long-term production potential of a stand.

Suitable, unsuitable and provisional are relative measures of how closely a project meets the test of all three criteria. The last row in the matrix indicates the project suitability decision, and provides either a justification or recommends a subsequent procedure.

In the first decision scenario (column 2) the proposed density management project is expected to produce a positive biological response, generate a positive stand-level economic outcome, yet result in a negative forest-level effect. The appropriate decision in this case is that the project is unsuitable because it confounds achievement of forest-level objectives.

The second scenario (column 3) is similar to the first, except the expected impact of the project at the forest level is neutral, instead of negative. This changes the decision to **provisional**, and a recommendation to proceed with the project depends on the availability of silviculture funds and the inclination of those managing the forest estate.

The third scenario (column 4) represents the most favorable measure of project suitability. Positive results were measured for all criteria. The resulting decision makes the project **suitable** since it contributes positively to management objectives, and is biologically and economically feasible.

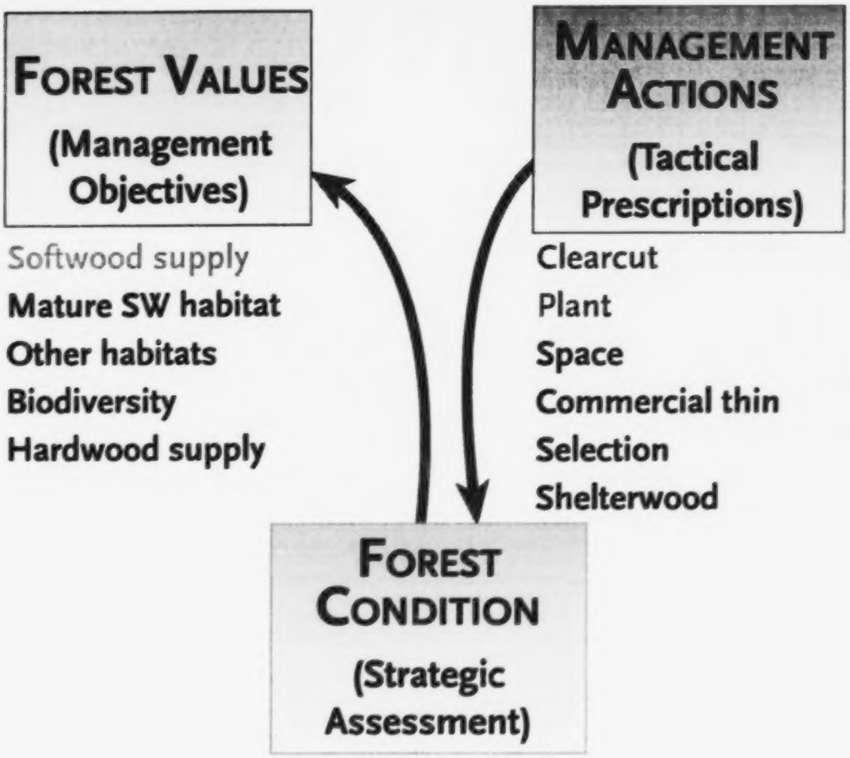
The positive (biological), negative (stand-level economic), and positive (forest level) combination in **scenario four** (column 5) results in a **provisional** decision, and a recommendation for minimum cost ranking. This means that the proposed project could be undertaken because of its capacity to yield a positive contribution to forest management objectives. However, there may be other projects also meeting objectives but capable of generating a more favorable (or less costly) economic outcome. Where funding is available, all stand density management activities would be

ranked in order from least to most costly. Stand density management projects would be undertaken in this order to a point where total density management program costs equaled available funds.

In the ***fifth scenario*** (column 6) the density management project is expected to yield a positive biological response, a negative stand-level economic response, and a neutral forest-level response. ***The project, in this instance, is unsuitable***. If a project has a positive biological impact, neither contributes to nor detracts from achievement of forest-level objectives, yet provides no net economic gain at the stand level, it would be difficult to justify the expenditure of silviculture funds. Practitioners should instead consider alternative projects or investments that provide greater returns and/or contribute more to achieving forest estate management objectives.

Adaptive Management

A New Brunswick Example



FOREST VALUES

(Management Objectives)

- Softwood supply
- Mature SW habitat
- Other habitats
- Biodiversity
- Hardwood supply

MANAGEMENT ACTIONS

(Tactical Prescriptions)

- Clearcut
- Plant
- Space
- Commercial thin
- Selection
- Shelterwood

FOREST CONDITION

(Strategic Assessment)

- Age structure
- Stand types
- Spatial pattern
- Vegetation communities
- Ecological land classes

Green – 1982 management objectives
Green + black – 1997 management objectives

A Structured Decision Process

Feedback is an essential part of any ongoing management regime.

The stand density management decision support process relies on:

- up-to-date knowledge regarding the biology of timber production, and current information regarding the people
- values and needs reflected in forest management plans
- scientific knowledge is continually updated through empirical observation and new discoveries
- forest management plans change with the participants, the economy and the times.

Thom Erdle in his paper *Progress toward sustainable forest management: Insight from the New Brunswick experience* (1998). Provides an example of the feedback loop described in the guidelines.

- The paper deals with shifting concept of sustainability.
- The example shows how all three parts of the decision process can change over time.
- The forest values (management objectives – as per the guidelines) have increased from only softwood supply in 1982 to incorporating supply along with mature shelterwood habitat, other habitats, biodiversity and hardwood supply.
- Forest condition is now assessed for age structure, stand types as it was in 1982, but now spatial patterns, vegetation communities and ecological landclasses are measured.
- Management actions have expanded to meet the increased level of stewardship to include spacing, commercial thinning, selection and shelterwood systems, from the former clearcut and plant of 1982.

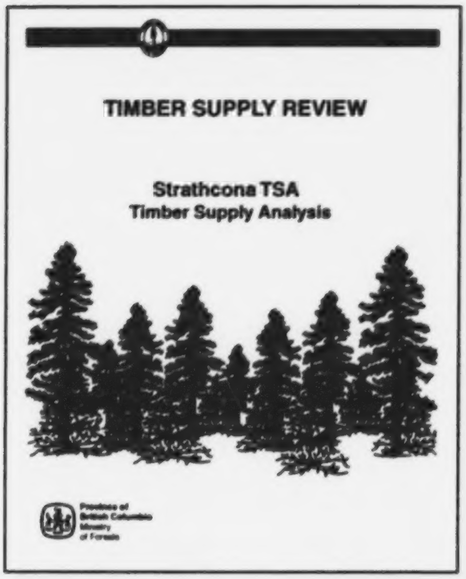
A BC example is next.

Real Life Example Strategy

Strathcona Timber Supply Area

Strategy at a glance

- General Strategy
- Working Targets
- Product Objectives
- Major Silviculture Strategies
- Incremental Silviculture Program



TIMBER SUPPLY REVIEW

Strathcona TSA
Timber Supply Analysis

Real Life Example Strategy

Briefly go over the topic areas. Have the participants spend 5–10 minutes looking at the strategy at a glance. Let them talk to their neighbour if they wish. Once they have had ten minutes, go over the sections in more detail, field any questions that emerge. Use local experts if available.

Strategy at a Glance[1]

General Strategy The focus of the silviculture strategy in the Strathcona TSA is to aid the redistribution of harvest between supply blocks, increase the supply of sawlogs during the mid-term period, diversify the age class structure, assist in managing for aesthetic and wildlife values, and increase the future supply of premium logs.

Working Targets

Quantity: Manage mid-term timber supplies to yield a harvest of approximately 1.10 million m^3/yr and long-term supplies to yield 1.25 million m^3/yr.

Quality: Manage regenerated stands to yield at least 6% premium logs by volume, with the majority of the remainder being of sawlog quality.

Product Objectives The following are product objectives at the log level for the Strathcona TSA.

Quality Class	Species	Characteristics
Premium Log:	Douglas-fir, clear, pruned	45+ cm min DBH, pruned, min 5 m log.
	Douglas-fir, large timber	55+ cm min DBH, unpruned.
	Douglas-fir, clear, unpruned	long rotation.
	Hemlock, large timber	55+ cm min DBH, unpruned.
	Hemlock, clear, unpruned	long rotation.
	Cedar, large timber	55+ cm min DBH, unpruned.
	Cedar, clear, unpruned	2 rotations in stand.
Sawlog:	Minimum average stand DBH of 45 cm and min. stand vol. of 350 m^3/ha.	

Continued on next page

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[1] *From Strathcona Timber Supply Area, Incremental Silviculture Strategy* (Interim) Version 1.0 – August 31, 1998.

Major Silvicultural Strategies

Quantity *(Some of the following are not within the traditional scope of incremental silviculture but are included here for completeness.)*

1. In the Sayward and Kyuquot SBs achieve a 3–5 year earlier green-up of regenerated stands through a variety of silvicultural practices.
2. In the Sayward, increase existing stand volumes 10% and diversify the age class structure by spacing 300 ha/yr, fertilizing1 500 ha/yr and commercial thinning 400 ha/yr.
3. In the Kyuquot and Loughborough SBs, move age class 1 & 2 stands ahead for earlier harvest and diversify the age class structure by spacing 1100 ha/yr and fertilizing 200 ha/yr.
4. Increase regenerated stand volumes 20% (tree improvement is critical to success).

Quality

1. Prune 250 ha/yr to increase the future supply of premium logs by 2%.
2. Manage selected stands for large dimension timbers.
3. Manage for clear timber through long rotations of selected stands.

Habitat

1. In the Sayward, create old forest characteristics as early as possible.
2. Space 50 ha/yr to [what density?] for [what purpose?].

Incremental Silviculture Program (ha)

Year	Surveys	Backlog Brushing	Space	Prune	Fertilize	Total
1	7,000	100	1,550	250	1,500	3,400
2	7,000	100	1,550	250	1,500	3,400
3	7,000	100	1,550	250	1,500	3,400
4	7,000	-	1,550	250	1,500	3,300
5	7,000	-	1,550	250	1,500	3,300
Subtot Yr 1 - 5	35,000	300	7,750	1,250	7,500	51,800
6 - 10	35,000	-	7,750	1,250	7,500	51,500
Total Yr 1 - 10	70,000	300	15,500	2,500	15,000	103,300

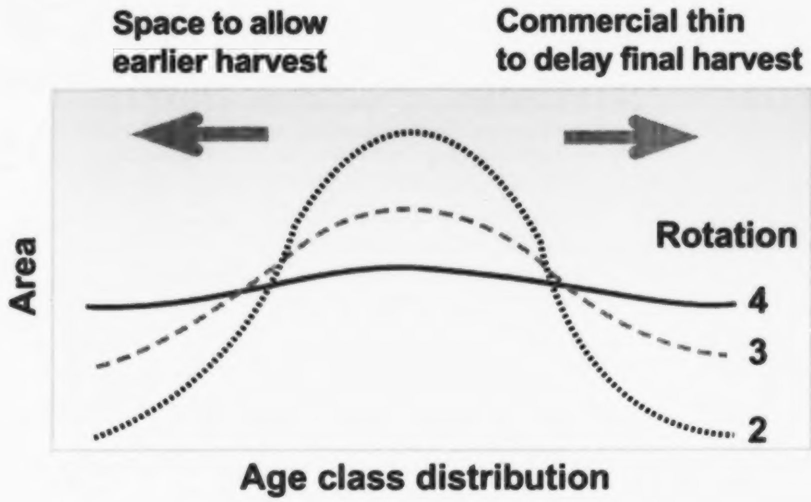
A Strategic Objective and a Tactical Response

Strategic Objective:

- **Break up the concentration of ages into a normal forest**

Tactical Response

- **spacing some stands to bring them to harvestable size earlier and move them forward in the harvest queue;**
- **spacing some stands to set up for CT; and**
- **CT some stands to delay final harvest by 1 age class.**



A Strategic Objective and a Tactical Response

Strategic Objective:

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Tactical Response

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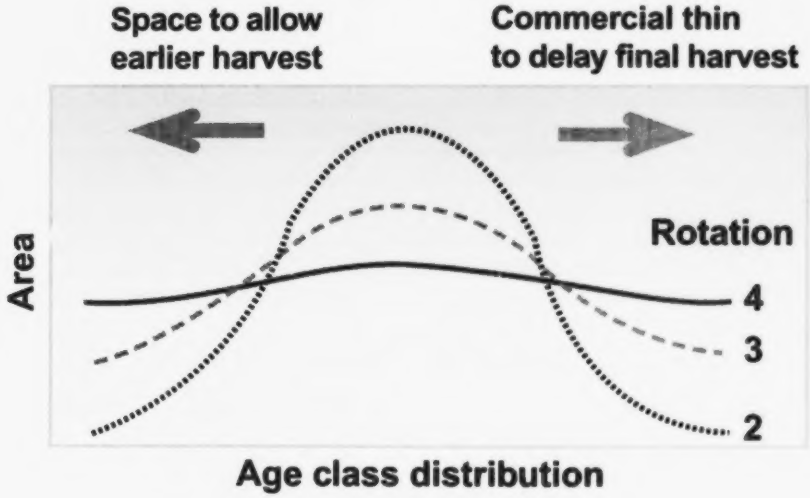
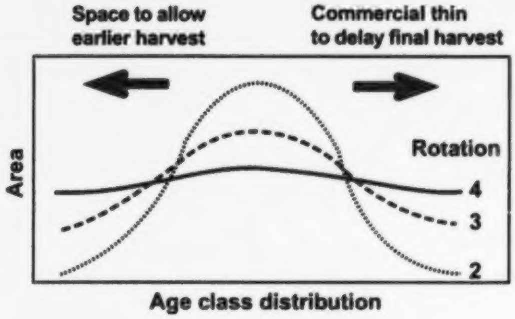


A Strategic Objective and a Tactical Response

Go over the two strategic objectives identified and the tactical options. **Note:** at this stage additional analysis may be needed to confirm options.

Strategic Objective	**Discussion – Current Status**	**Anticipated Result**
Break up the concentration of ages into a normal forest by:	1. The diagram below shows how over several harvest rotations, the strategy will redistribute the age classes into a more even distribution. 	1. Effect unknown – requires modelling. Ultimately beneficial in meeting adjacency/ green-up requirements. Allows for the Sayward to be potentially managed as an independent management unit at some future time.
Tactical Options a) spacing some stands to bring them to harvestable size earlier and move them forward in the harvest queue; b) spacing some stands to set up for CT; and c) CT some stands to delay final harvest by 1 age class.	The district expects to soon assign to every stand a target harvest age within 5 year age groupings. a) Current program is to **space 200 ha/yr for bringing harvest ages forward** b) Current program is to **space 100 ha/yr for setting up for CT**. c) Current program is to **CT 400 ha/yr** for the dual purpose of delaying final harvest ages as well as overcoming adjacency constraints.	

Consequences – If the strategy is not followed, given the dynamics of the TSA with 3 supply blocks, the cut would rotate heavily from supply block to supply block – coming in, maxing out to the limits of forest cover constraints, and then rotating to the next supply block and doing the same thing. This would reduce flexibility and potentially result in additional public derived constraints.

Strategic objectives Create old forest characteristics as early as possible Tactical option through a regime of spacing/fertilization/CT/ ertilization.	2. The Sayward has few older forests. Anticipated as a future issue – TSR 1 did not include an older forest requirement in base case. Forest structure can be advanced similar to that of older forests through this strategy. Existing programs will accomplish this.	2. Effect unknown. No TSR 1 sensitivity test. Requires modelling.

Strategic Objective

A suggested approach...

- Someone needs to do advance preparation
- Use a workshop to go over the options
- Be sure you have the "right" participants and that they are welll prepared

An Approach That Has Been Used In Several BC TSAs[2]

Advance preparation of between 7 to 10 days is needed to go over the Timber Supply Review and prepare potential strategies. This must be done by someone who is familiar with the inner workings of the timber supply. When working with the timber supply you have to separate modeling phenomenon from true timber supply effects. You also have to speculate on what a potential harvest forecast might look like without the shackles placed on the TSR analysis. TSR is about the present – silviculture strategy is about creating a future.

A strategy is only good to the degree that it **proves appropriate and is achieved.** For example, the Fraser TSR basecase took a steep dive and then leveled out at the LTHL. A hypothesized new forecast created a 40% increase at year 50! You can imagine the difference in strategies that that generates.

You also need to look at not only opportunities to increase timber supply, but also where silvicultural interventions may protect against risks to timber supply. A good example here is when sensitivity analysis shows a relatively small increase in forest cover constraints over the current practice would result in an inability to maintain the current harvest level. Here, perhaps increasing the use of partial harvesting or CT might be a good preventative measure. Better yet, is when doing so would actually free up timber supply that is otherwise unavailable. Sometimes these become no-brainers as a first choice strategy; if constraints do become tighter, you've helped offset the impact and if they don't become tighter, you get a gain in timber supply over the base case.

Part of the process, too, is a gap analysis. What additional information do we need to know? For example, in Kootenay Lake, the easiest increase in timber supply could come from sites classified as low but that are actually poor. If low, they're outside the THLB, if poor, they're in. The solution was go out and re-assess/re-classify the low sites. Once they have a handle on it, they can then see if there's any opportunity for silviculture (e.g., rehab, fertilization) to bring any of the residual low-site area into the THLB. Another example, no one knows what their local OAF1 is, yet there are survey methods now available.

As can be seen numerous options exist and will vary by TSR and TFL. To make the plan specific to a TSA the following should attend a facilitated workshop to develop a silviculture strategy.

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[2] Outlined by Larry Atherton who has been involved in a number of TSA Incremental Strategies under contract to the Ministry of Forests, funded by FRBC.

NOTE: A central aspect of the workshop is that you must have the people with the essential local knowledge in the room. This is THEIR plan, not the people who facilitate it. These people are:

- ▲ district silviculture planners
- ▲ a senior district management person
- ▲ the timber supply analyst – either the regional or district person
- ▲ a regional silviculture specialist or two (no more)
- ▲ MOELP rep
- ▲ each major licensee
- ▲ First Nations, if appropriate.

What should they bring?

- ▲ knowledge of current silv practices and opportunities (e.g., fert is a great idea, but if there are no suitable candidate stands…)
- ▲ program level in the management unit
- ▲ local stand treatment priorities, if any
- ▲ local financial analysis of silviculture investments, if any
- ▲ local timber product objectives, if any
- ▲ local habitat objectives
- ▲ species trends in reforestation (e.g., spruce going down, pine going up)
- ▲ status of tree improvement program for local species
- ▲ latest timber supply analysis report and AAC rationale
- ▲ timber supply analysis detail, if available (analyst to bring)

See the *Strathcona Timber Supply Area Incremental Silviculture Strategy* (Interim) Version 1.0 in your appendix for further detail. See also the chief forester's policy for additional guidance.

Lesson 7

Policy and Regulations

What is new and what is not

90 minutes

Lesson Objectives

- To provide participants with the most up-to-date policy direction based on the regulations in place.
- To help interpret the policy and regulations.

Method: Chief Forester Policy and Pertinent Regulations – Lecturette

- Go over the summary of key changes,
- Highlight the applicable regulations,
- Provide example Q and As.

Audio Visual Requirements

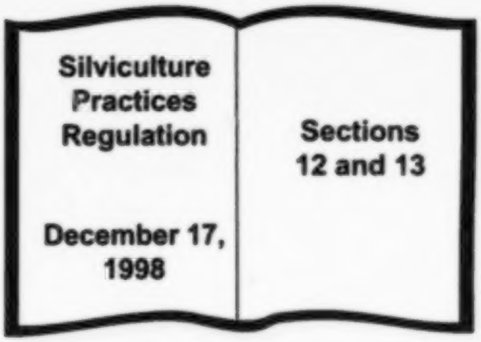
- Overhead projector

Handout

In participant's workbook

Example Q and As.

Stand Density Management



Silviculture Practices Regulation

December 17, 1998

Sections 12 and 13

Regulation changes from the April 1, 1998 SPR

Section 12 – removes former maximum density requirements from old SPs and PHSPs

Section 13 – rebuilds new requirements

Maximum Density

- is now set at 10 000 sph unless specified otherwise by the regional manager.
- regional manager may specify a maximum density other than 10 000 sph.
- regional manager is not required to deviate from the default maximum density number of 10 000 sph.
- if over the maximum the SP holder must space to range specified in SP.

Key Regulation Changes with Respect to Maximum Density

Summary of Key Changes

- general structure similar to the December 1997 OIC and the April 1, 1998 SPR
- SPR Section 12 exempts the requirement for maximum density for all previous SPs
- SPR Section 13 rebuilds back in the maximum density obligation

This amendment changes the SPR section 13 from the April 1, 1998 version in the following ways:

- the maximum density is set at 10 000 for all past and future prescriptions
- the regional manager may specify other numbers than 10 000 for both past and future Silviculture Prescriptions if he has followed the chief forester's policy and procedures
- there is a provision for the regional manager to make these new maximum density numbers retroactive on silviculture prescription areas that have not been declared free growing
- regional managers are not required to deviate from the default maximum density number

Specifically

Section 13

This section establishes new maximum density obligations to replace the exemptions given in SPR Section 12. Under this new section, the district manager no longer has the authority to set out maximum density numbers. The authority to deviate from 10 000 sph resides with the regional manager.

Section 13 (1)

This section specifies that the maximum density of all SPs approved on or after April, 1994 will be considered to be 10 000 or another number specified by the regional manager. **If the number of coniferous trees exceeds 10 000 or a number specified by the regional manager, the SP holder must reduce the stand density to the post-spacing density range specified in the SP.**

Stand Density Management

Silviculture Practices Regulation

December 17, 1998

Sections 12 and 13

Maximum Density – when to deviate from 10 000

When regional manager feels the number does not adequately manage and conserve the forest resource 13 (3), and

RM
CF Policy

Only if I want to – 13(4), but must follow g and p 13 (7) if I deviate

The chief forester has created policies and guidelines respecting 13 (6):

- A maximum other than 10 000 sph
- Characteristics of a counted tree
- Different areas and species

Key Regulation Changes with Respect to Maximum Density

Summary of Key Changes

This amendment changes the SPR section 13 from the April 1, 1998 version in the following ways:

- ▲ the regional manager may specify other numbers than 10 000 for both past and future Silviculture Prescriptions if he has followed the chief forester's policy and procedures
- ▲ regional managers are not required to deviate from the default maximum density number

Specifically

Section 13 (3)

This section gives the regional manager statutory authority to specify a maximum density number other than 10 000 provided that he is satisfied it is necessary in order to ensure that the forest resources are adequately managed and conserved. The regional manager may only create different maximum density numbers if the chief forester has established policies and guidelines.

Section 13 (4)

This section is intended to provide the regional manager with the authority **not to deviate from the default maximum density standard. He can not be compelled to specify another number if he does not wish to specify another number.** The intent of this section is to allow regional managers to have full control over when and if he wishes to deviate from the default maximum density number.

Section 13 (6)

This section gives the chief forester the authority to establish, vary or cancel policies and guidelines regarding the regional manager's specification of different maximum density numbers.

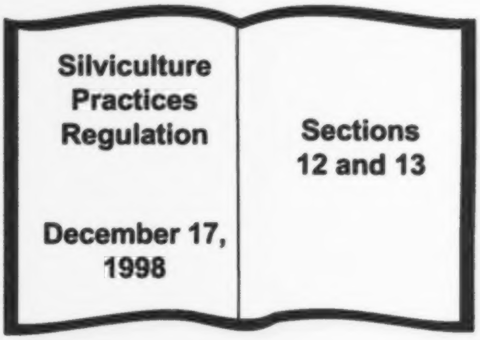
The section also provides the chief forester with the ability to establish, vary or cancel policies and guidelines respecting the characteristics of trees that must be counted for the purposes of determining maximum density obligations. This can include countable height and health conditions.

Initially the *Guidelines for Developing Stand Density Management Regimes* is the chief forester's guidelines. The *Stand Density Management Policy* is the chief forester's policy for stand density management. It is anticipated that over time the chief forester may issue additional policies and guidelines for specific areas or stand density management issues. These documents will be widely available in February 1999.

Section 13 (7)

This section is intended to compel the RM to follow the policies and guidelines developed by the chief forester.

Stand Density Management


Silviculture Practices Regulation
December 17, 1998
Sections 12 and 13

Maximum Density – District Manager's Role

- **Consultation and review in the setting of maximum density numbers developed by the regional manager (no longer district manager's role to set maximum density numbers).**
- For pre-1994 SPs:
  - over the maximum density
  - with no post-spacing density ranges specified (Pl & Fdi)

the district manager can specify a post-density range if the target will not adequately manage and conserve forest resources.

Key Regulation Changes with Respect to Maximum Density

Summary of Key Changes

This amendment changes the SPR section 13 from the April 1, 1998 version in the following ways:

- district managers will no longer be responsible for specifying or establishing new maximum density numbers. However, they are expected to be involved in the consultation and review process when new numbers are being developed by the regional manager
- for pre-1994 silviculture prescriptions (which do not have a post spacing density ranges specified) the district manager can specify the post-spacing density range by notice to the licensee

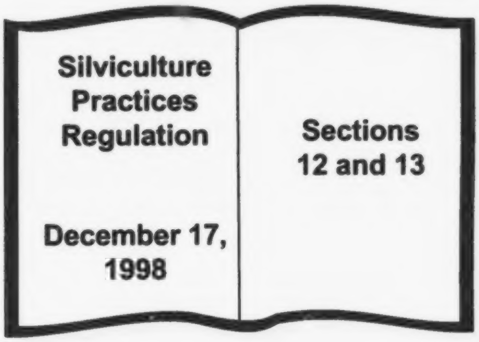
Specifically

Section 13 (2)

This section specifies that the maximum density of all SPs approved before April, 1994 will be considered to be 10 000 or another number specified by the regional manager (for Pl and Fdi). If the number of coniferous trees exceeds 10 000 or a number specified by the regional manager, **the SP holder must reduce the stand density to the target stocking standard specified in the SP or to within a range specified by the district manager.**

In SPs approved prior to April 1, 1994, there was no specification of post-spacing densities to be achieved on areas with a maximum density obligation. This section clarifies what the post spacing density must be before the end of the free growing assessment period.

Stand Density Management



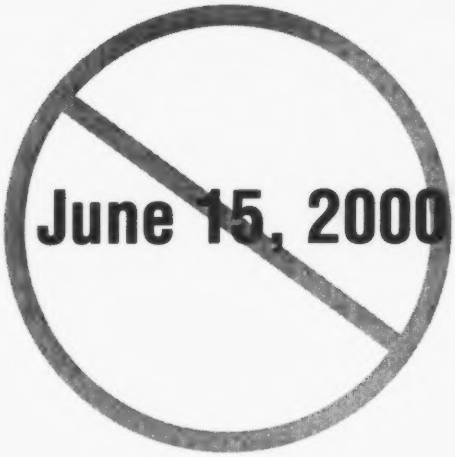
Silviculture Practices Regulation

December 17, 1998

Sections 12 and 13

Regulation changes from the April 1, 1998 SPR

Maximum Density – No deadline



June 15, 2000

Key Regulation Changes with Respect to Maximum Density

Summary of Key Changes

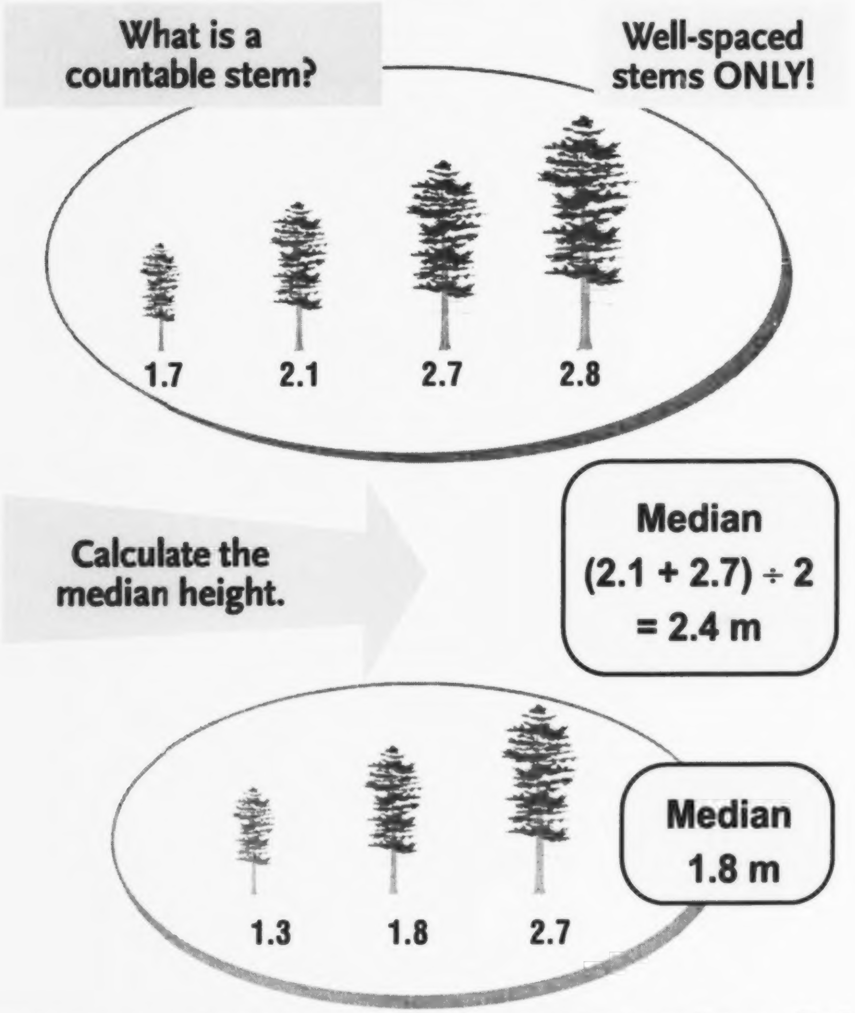
- general structure similar to the December 1997 OIC and the April 1, 1998 SPR
- SPR Section 12 exempts the requirement for max density for all previous SPs
- SPR Section 13 rebuilds back in the maximum density obligation

This amendment changes the SPR section 13 from the April 1, 1998 version in the following ways:

there is no longer a deadline for the production of new maximum density numbers. The April 1998 version of the SPR required new numbers to be established by June 15, 2000, or the previous SP numbers would come back into effect. Due to staffing, funding and workload issues, operational staff have requested the removal of the deadline.

Stand Density Management

Maximum Density – What is counted? 13(9)



What is a countable stem?

Well-spaced stems ONLY!

Calculate the median height.

Median
(2.1 + 2.7) ÷ 2
= 2.4 m

Median
1.8 m

What is a Countable Stem

FACILITATOR: **Go over the concept of countable stems – use the overhead example to emphasize what is meant by median height.**

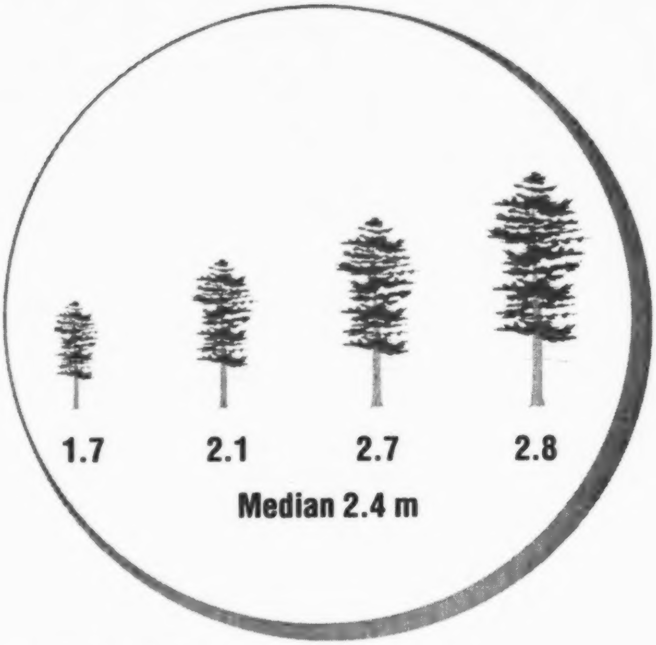
Go over the two examples and show how median height is calculated. It is very simple for odd numbers of stems as it is the height of the middle tree. For even numbers you add the two in the middle together and divide by two.

Point out the difference between median and mean (the mean is the arithmetic average). The mode, if someone brings it up, is the most common number in the group – 1.2, 1.2, 1.2, 3 – has a mode of 1.2.

Note: ***The median height is calculated for each plot and used to determine countable stems.***

Stand Density Management

Maximum Density – What is counted? 13(9)



All stems above:

20% of the median height

20% of 2.4 = 48 cm

Note – only layer 3 (1.3 m to 7.5 cm dbh) are counted for uneven-aged management.

What is a Countable Stem

FACILITATOR: **Go over the concept of countable heights – use the example to indicate the countable height criteria for a median height.**

Why the need for countable heights – why was 20% chosen?

Median height is 2.4 (2.1 + 2.7 ÷ 2 = 2.4)

The intent of having a minimum height criteria is to avoid counting stems towards maximum density when there is little likelihood of them being competitors.

Twenty percent was used to provide a level of certainty that non-countable trees would eventually become competitors and reduce diameter growth potential. The initial number was any stem that became established during the first seven years post harvest.

Note: ***The 20% factor was chosen by a ministry/industry working group given the task of defining a countable stem. The new working group revisiting this issue again and reconfirmed using 20% of the median height as a countable stem.***

Stand Density Management

Chief Forester's Policy

Definition of Maximum Density –

- The maximum number of coniferous trees allowed per ha in a free growing stand
- Without density control, will not produce acceptable stand conditions in an acceptable timeframe
- Not equated with repression density

Note:

- Only those portions of a standards unit that exceed this number must be spaced.

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Maximum density – the maximum number of coniferous trees allowed per hectare in a free growing stand. This number is specified in countable trees per hectare.

- Without density control, areas exceeding the specified maximum density number are not expected to produce the acceptable stand conditions within desired time periods.
- Only those portions (i.e., a forest cover or survey strata) of a standards unit area within a Silviculture Prescription that exceed this number must be spaced.

Maximum density is not to be equated with a repression density or stand densities that result in reduced site index.

Countable trees – are trees that meet specific height criteria or characteristics, and are tallied in a silviculture survey to determine stand density and maximum density obligations.

Stand Density Management

Chief Forester's Policy

Guidelines provide guidance and are not a "how to"

Policy helps define how to use the guidelines

You need a team:

- Knowledgeable folks from your area.

You need to know what you want:

- A series of density management regimes and maximum density values for a regional, district, geographic, or licensee-specific area.
- Maximum density numbers should preferably be based on a management unit basis (i.e., TSA/TFL). However, they may be developed on a management zone, ecosystem, or diversified portfolio basis.
- This approach can be used for discretionary/incremental funded priority setting as well (recommended).

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Who should be involved?

- regional, district, licensee foresters, Ministry of Environment, Lands and Parks, and other agencies or groups deemed appropriate by the regional manager.
- the regional manager may require density management regimes to be reviewed with other agencies or groups.

What should be produced?

- a series of density management regimes and maximum density numbers that are applied on a regional, district, geographic, or licensee-specific area.
- maximum density numbers should preferably be based on a management unit basis (i.e., TSA/TFL).
- however, they may be developed on a management zone, ecosystem, or diversified portfolio basis.

Stand Density Management

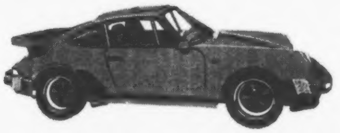
Chief Forester's Policy

Policy helps define how to use the guidelines

You need to know who does the analysis

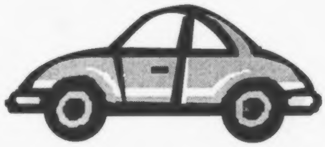
- may be done by region, district, or licensee staff
- must be consistent with chief forester policy
- must be done in consultation with district and regional staff.

You need to know how to do the analysis



Full stand- and forest-level evaluation and analysis of different regimes

Piggy back with other initiatives



Best estimates based on a series of meetings with appropriate stakeholders and subject matter experts

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Who does the analysis? – may be done by region, district, or licensee staff, but must be consistent with this policy. The analysis must be done in consultation with district and regional staff.

How to do the analysis–

- The most desirable approach for the development of new density management regimes is to carry out full stand and forest level evaluation and analysis of different stand density management regimes.
- Where possible, the development of stand density management regimes should be integrated with other analyses currently underway (e.g., analyses for Innovative Forest Practices Agreements, Enhanced Forest Management Pilot Projects, Timber Supply Review 2, Forest Level Incremental Silviculture analyses, etc.).
- In some cases staff time and funding may be limited and preclude a full scale analysis. Regions, districts, and licensees may develop new numbers (best estimates of density management regimes that are appropriate for different areas and conditions) by setting up a series of meetings with appropriate subject matter experts and operational staff.

The regional manager is the statutory decision maker responsible for the specification of any new maximum density numbers and should therefore approve which approach is taken and the assumptions to be used in the development of new numbers.

Stand Density Management

Chief Forester's Policy

What should go into the building of regimes

You need to know who does the analysis

- forest product objectives
- consider existing stocking standards – minimums and targets
- existing higher level plans
- options and risks
- maximum density to coincide with minimums and targets
- wildlife and forage information
- understorey biodiversity values
- special ecosystems
- partial cutting
- forest health
- landscape-level objectives

Areas outlined in green may require additional assessments from those outlined in the guidelines.

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Forest production objectives – high value forest products is the objective unless otherwise specifically identified in existing woodlot management plans, TFL management plans, or TSA objectives.

Consideration of existing stocking standards – new stand density regimes should be developed with consideration of the forest or product objectives that are embodied in existing minimum and target stocking standards.

Existing higher level plans – stand density regimes that are identified in higher level plans (i.e., Land and Resource Management Plans or Landscape Unit Plans) must be considered in any analysis.

Options and risks – stand density regimes should be developed that maintain options and minimize risks for future generations. Stand density regimes should ensure options are maintained for future harvest ages, species mixes, and forest values.

Target stocking standard – unless the district manager approves otherwise, the target stocking standard should be set at the density of trees at the free growing time period that will achieve the target stand conditions at the specified harvest age.

Minimum stocking standard – unless the district manager approves otherwise, minimum stocking standards should be set at a density of trees that considers the entire silviculture regime, including any intermediate interventions, and does not result in significant merchantable volume reductions compared to a stand at the target stocking standard.

Maximum density or upper density limit – should be developed with consideration of the desired target and minimum stocking standards and consistent with analyses done using this policy and the guidelines.

Stand Density Management

Chief Forester's Policy

Forest and Stand Modeling Assumptions and Requirements

See Policy for details

Chief Forester's Policy

Go over the following: Straight from the Policy Document

The following are minimum forest and stand modelling assumptions and requirements that should be included in the development of stand density management regimes:

- utilization standards – unless otherwise approved by the regional manager, use assumptions consistent with the current or last approved Timber Supply Review
- ensure that the key Forest Practice Code requirements (i.e., green-up, riparian management zone requirements, landscape unit objectives) are considered
- use appropriate stand and forest level models
- ensure key assumptions included in the analysis consider the current or recently approved TSR
- where there is a need to make significant variances from the current or last approved TSR, new assumptions need to be reviewed with and approved by the regional manager
- consider the need for any intermediate interventions (i.e., commercial thinning) in the design of stand density management regimes
- yield curves used to represent an analysis unit in a forest level analysis (unique combination of species, site class, and density management regime) must be realistic and adequately represent site conditions and the intended management objectives and practices and basic silviculture obligation levels
- the evaluation and determination of a stand density regime will result in the identification of stand densities that are desired at various time periods during the development of a stand. Consideration must be given to the types of operable stand conditions (such as piece size distribution, merchantable volume) that are needed to ensure a stand can be economically harvested. The evaluation should result in the identification of appropriate density management standards that ensure stand, landscape, and/or forest objectives can be achieved.

Stand Density Management

Points in Specifying a Maximum Density Number

- 10 000 is the default for SPs unless new numbers have been developed under SPR 13, the guidelines and the chief forester's policy
- New maximum density numbers should consider stand, forest and landscape objectives
- They should be aimed at improving or maintaining an economically viable timber supply
- Some maximum density numbers may be created to achieve wildlife objectives

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Key points in the specification of a maximum density number:

1. The default maximum density number to be included in Silviculture Prescriptions is 10 000 sph unless new numbers have been developed following the Silviculture Practices Regulation Section 13, the *guidelines,* and this policy.
2. Any new maximum density numbers should be developed with consideration of stand, landscape, and forest issues and objectives. They should be aimed at improving or maintaining an economically viable timber supply.
3. Specific stand densities may be required to achieve wildlife objectives identified in a higher level plan, a TFL management plan, or *Managing Identified Wildlife: Procedures and Measures*. In select areas, maximum density numbers may be specified for ungulate winter range, special management zones, and/or wildlife habitat areas.

Stand Density Management

Points in Specifying a Maximum Density Number

- For applying density numbers on pre-1997 SPs they should not be more onerous.
- Regional manager can vary from 10 000 if the regional manager considers a number other than 10 000 is needed to adequately manage and conserve the forest resources.

Chief Forester's Policy

Go over the following: Straight from the Policy Document

Key points in the specification of a maximum density number:

4. When specifying any maximum density numbers that are to be applied to SPs approved on or before December 30, 1997, the regional manager should consider the potential financial implications. The regional manager should not normally specify a retrospective number that would result in a more onerous financial obligation than the maximum density numbers contained in SPs approved on or before December 30, 1997.
5. The regional manager may specify a maximum density number other than 10 000 if satisfied that a number other than 10 000 is necessary to ensure that the forest resources are adequately managed and conserved in an area. In determining adequate management and conservation of the forest resources, the regional manager should consider points 1–4.